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Born from a bet

Why the TVR Griffith is finally delivering on a wager made more than 50 years ago

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Professionals welcome, to a point

As will be seen in the news, more and more teams that compete in the British Touring Car Championship are entering historic racing, which shows just how popular this branch of the sport has become. These teams bring with them a level of professionalism and expertise that has rarely been experienced in historic racing, at least when it comes to Touring Cars. That is not to decry those teams that already compete in the series, but what the BTCC outfits bring with them is a level of resource in terms of personnel, equipment and finance that has not been seen before in these circles. The danger is that the casual historic racer, who does it more for fun than anything else, will be priced out of the competition.

The entry of such professional race teams is a double-edged sword and one that the various organisers need to be aware of because the backbone of historic racing has always been, and should be, the privateer amateur who is doing it for fun. Lose them and we lose what makes historic racing what it is.

It is the same dilemma but in a different scale that even Formula 1 has faced. Encouraging the manufacturers to come into the championship brings with it a huge level of resource, greater publicity and more prestige. Once they leave, though, as they do, it leaves the privateers to pick up the pieces. Look at Le Mans and the World Endurance Championship. When Audi, Porsche and Toyota were all competing for overall honours in LMP1, the races were alive and vibrant, but now that the two German teams have left, it has left just Toyota to be the sole works LMP1 team with its two cars. Any victory will be slightly hollow even though the Automobile Club de l'Ouest, the sanctioning body along with the FIA, has quickly revised the regulations to make the privateers more competitive.

Having professional race teams enter historic racing is quite a coup for the organisers, but it cannot be at the expense of the stalwarts, the teams and individuals who have always competed, even on a shoestring.

On a different matter, I am delighted to see that the Masters Endurance Legends will now be a support race at the Silverstone Classic. There will be some who argue that a car that has raced as late as 2011 should not be considered historic, but when you consider what might be racing at Silverstone in July, then I think those objections will be overcome. It was quite a brave move for the Masters to go in this direction and build a series for endurance cars that competed between 1995-2011 but it is one which I am sure has been the right move. HRT

William Kimberley
Editor




Motorbase

ABOVE The Motorbase Mustang on arrival from California, before stripping for its rebuild to race specification

BTCC teams plan historic campaigns

Andrew Charman

TEAMS in the British Touring Car Championship are transferring the technical skills employed in the UK's biggest motorsport series to historic racing, with Kent-based Motorbase Performance the latest to take the plunge.

Motorbase, which runs a three-strong team of Ford Focus cars in the BTCC under the Team Shredded Wheat banner, has purchased a 1965 Ford Mustang from California for team principal Dave Bartrum to campaign in the Historic Racing Drivers Club (HRDC) Allstars series.

The car has been prepared during the year in between the team's BTCC commitments, and is set to be completed in March. High profile outings such as the Goodwood Members Meeting and Silverstone Classic are being targeted for Bartrum's first races since 2002.

Meanwhile father-and-son BTCC drivers Mike and Andrew Jordan are to expand their historic operation, and build a TVR Griffith to race in the 2018 season.

The Jordan Racing Team has already made its mark in historic competition, first entering in 2015. Most recently with a highly competitive showing at the Goodwood Revival St Mary's Trophy races in an Austin A35.

Jordan Snr raced in the BTCC between 1989 and 2008 while Andrew won the series in 2013 and currently competes under the Pirtek Racing banner as part of the West Surrey Racing works BMW team.

The team's workshop will be expanded while the V8-engined Griffith will be built in conjunction with Nigel Reuben Racing to compete in pre-66 GT races. Mike Jordan already has Griffith experience, having shared the race-winning cars of Mike Whittaker in many events.

Multiple BTCC title winner and Honda works squad Team Dynamics has also been competing successfully in historic events, drivers Matt Neal and Gordon Shedden campaigning a Lotus Cortina built up in the team's Pershore workshop.

* *Historic Racing Technology* is following the build of the Motorbase Mustang – look out for a feature on the car in a forthcoming issue. HRT



Andrew Charman



ABOVE The Jordan family have already carved out a historic racing reputation, including in this Austin A35 at the Goodwood Revival

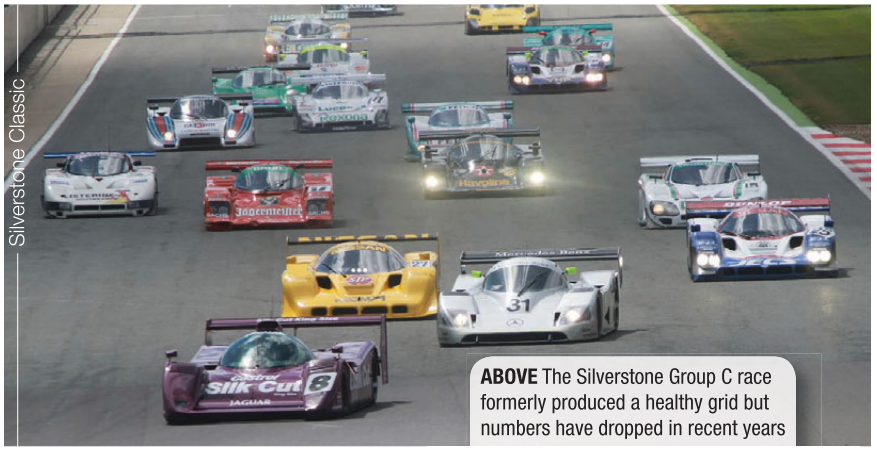


ABOVE The Masters Endurance Legends series staged a successful initial race at Spa in September

Silverstone Classic cans Group C race

Andrew Charman

THE race for Group C cars that has traditionally run into Saturday evening at the Silverstone Classic will not happen in 2018. Instead organisers have signed up the new Masters Endurance Legends series for endurance prototype and GT cars from 1995-2011 – these will be the most recent cars to compete on the Classic programme and form part of a three-race celebration of 60 years of the Le Mans 24 Hours.



ABOVE The Silverstone Group C race formerly produced a healthy grid but numbers have dropped in recent years

The Masters Endurance Legends series staged its first pilot race at Spa in September and attracted 21 cars. In contrast the Group C Series, once a major attraction at the Silverstone Classic, could only muster a 13-car entry for the 2017 event which by the end of the second race was down to nine.

Prospects for a healthy Group C field at the 2018 meeting have been further hit by plans by Peter Auto to stage a Group C race at the Le Mans Classic on 6-8 July – only two weeks after the Silverstone event.

Meanwhile the two leading organisations running Group C races – the US-based Historic Sportscar Racing and Peter Auto – have agreed on a standardised set of regulations and technical specifications, which in itself should help grid numbers.

The new regulations have been adopted immediately and the Group C races at the HSR Classic meeting held at Daytona International Speedway on 8-12 November ran to them. The Classic 12-hr race at Sebring on 30 November to the 3 December was also set to adopt the regulations, additionally, by racing in both events competitors will qualify to take part in the Group C race that Peter Auto is organising at the Le Mans Classic in July. HRT

Continuation race cars given safety break by MSA

THE MSA has made changes to its technical regulations to remove a safety equipment anomaly between original historic race cars and modern versions built to the same specification, such as replicas or continuation cars.

Previously, such cars were not able to take advantage of the exemptions from the fitting of safety equipment that the original period cars enjoy. The new rules, which do not apply to rally cars, redress this anomaly.

The existing eight historic vehicle classes that are separated by date (for example A1 covers veteran cars of before 1905, H1 cars between 1 Jan 1972 and 31 Dec 1976) will be altered by replacing the words 'cars built...' with 'cars of a specification valid...'

An additional eight classes will be added for non-historic vehicles, identical to the historic classes apart from the phrase 'cars of which the latest major component is of a specification valid...' The rules also work in the opposite direction – a car built originally in the period but since having its major components (chassis, bodywork/bodyshell, engine, transmission, brakes, suspension and wheels) modified to modern specification, making it capable of considerably improved performance, will no longer benefit from safety exemptions due simply to original build date.



ABOVE Cars such as the Lister Knobbly Continuation will benefit from the new rule

The full regulations, decided by the MSA's Motor Sports Council, apply from January 2018 and will be found in the 2018 edition of the MSA Yearbook. HRT

NEWS

South African GP festival to recall 1930s



ABOVE The ERA that won the 1937 South African GP is set to take part in the 2018 celebration event

Andrew Charman

SPEEDSTREAM Events is to stage a three-part South African Historic Grand Prix Festival in November 2018, and expects a full grid of cars from the 1930s to take part in the event. The event will recall a 'winter series' held between 1934 and 1939 and comprising the South African GP at the Prince George track in East London, the Grosvenor GP in Cape Town and the Rand GP in Johannesburg. Many leading European and British drivers of the day took part in these races.

First of the three elements, between 25 November and 2 December, will be a commemorative race at the East London Grand Prix Circuit combined with a parade around the original 11-mile long Prince George race circuit.

This will be followed by a five-day private tour for the roadgoing GP cars, through some of South Africa's most scenic routes between East London and the Western Cape. The final event will be a two-day Grand Prix Garden Party, at a yet-to-be-confirmed venue close to Cape Town, with the cars on display and demonstrated.

Speedstream has made efforts to identify and trace as many of the original cars that participated in the South African events during the 1930s and says that several cars are already committed to participating, including the Maserati 8CM with which Whitney Straight won the inaugural 1934 GP, the ERA which won the 1937 GP and the Riley Ulster Imp which finished second in the same event.

The up to 25-strong invitation-only event is also expected to include cars from Bugatti, Alfa Romeo, Talbot, Frazer Nash, Aston Martin, MG, Railton and Plymouth as well as further ERAs, Maseratis and Rileys. Preference will be given to entries with authentic South African GP history, but owners of age-related GP cars may also be able to participate in the once-off event. HRT

Caterham launches Seven SuperSprint retro racer



ABOVE Caterham celebrated its 60th anniversary with a 1960s style SuperSprint at the Goodwood Revival

Alan Stoddart

AS part of its 60th anniversary celebrations, Caterham launched a retro-styled limited edition Seven SuperSprint at the Goodwood Revival.

The 60 SuperSprints complete the pair of special models that have opened and closed the marque's anniversary year. The similarly retro Seven Sprint was launched at the same event 12 months previous, when all 60 cars sold within a week, making it the fastest selling Caterham Seven to date.

As well as offering a dose of gentleman racer style, the power of the car's 95bhp Caterham Works Racing-tuned, 3-cylinder engine means it is equally at home on the road and the track.

The SuperSprint features a unique Brooklands windscreen, quilted and stitched seats trimmed in Innes tan Scottish Muirhead leather and a wooden-rimmed sports steering wheel. Outside, a 1960s-style livery and six signature paint schemes named after classic race circuits help complete the nostalgic feel.

With 1960s race style front of mind, Caterham has also created a single-seater option, which comes complete with a tonneau cover for the more serious driver looking to strip out as much weight as possible.

"Motorsport and the purist thrill of driving a lightweight race car is in the Caterham Seven's DNA and are elements that run like a thread through every car we build today, 60 years after the first Seven was made," said Graham Macdonald, Caterham chief executive officer.

"We started our 60th anniversary year with the glorious throwback Sprint – aimed at the more discerning chap or lady driver. As we approach the end of our year of celebration, it makes perfect sense that the car bookending the celebrations is a racer of a similar vein." HRT


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ABOVE The HSCC is celebrating the 60th anniversary of Formula Junior, one of the most popular historic racing series

NEWS

Historic Sports Car Club to celebrate Formula Junior's 60th anniversary

Alan Stoddart

THE Historic Sports Car Club's presence at the Autosport International show will include a line-up of Formula Junior cars to celebrate 60 years since inception of the open wheel series.

First adopted in October 1958, the class was intended to provide an entry level where drivers could use inexpensive mechanical components from ordinary roadgoing cars. In its six short years, the design span covered the major progression of racing car evolution from ladder frame front-engined cars onwards.

The cars on display at the HSCC stand will demonstrate how much race car design advanced during this short period. The display is set to feature a Formula Junior car from each year of the championship, including a Stanguellini - the marque that won the very first Formula Junior race at Monza in April 1958 - and a 1961 Lotus 18 from Classic Team Lotus which was driven by Jim Clark.

Although Formula Junior only existed until 1963, it remains one of the most popular of all historic racing categories, with huge worldwide interest in the category for 1100cc single-seater racing cars.

Jim Clark, John Surtees, Jochen Rindt, Mike Spence, Mike Hailwood, Graf Wolfgang Von Trips, Gerhard Mitter, Lorenzo Bandini, Peter Revson, Giancarlo Baghetti and Howden Ganley, were just some of the names to start their careers in the series.

The 2018 season is a particularly special year for Formula Junior, as the category's 60th year is also the final season of a three-year Diamond Jubilee World Tour. The Tour, which has already visited Australia and New Zealand, South Africa and North America, will finally conclude at the Silverstone Classic in July.

Grahame White, the chief executive of the HSCC, said he was "really pleased" that the HSCC stand will be celebrating 60 years of the Formula at the show. "It is a great category of historic racing providing superb grids, many different makes of cars and very close and exciting racing, not to mention being where many famous drivers started their careers," he said. HRT



ABOVE Jim Clark was one of many famous names to get their start in the series

More Equipe in 2018

Andrew Charman

THE successful Equipe GTS historic series is to spawn a sister championship for pre '63 cars in 2018.

The series is expected to attract period E specification 1950s and early 1960s cars, such as the Healey Sprite, 100 and 3000, the Jaguar E-Type and XK, Morgan, MGA and Lotus Elite. The 1963 cut-off date has been decided on to exclude the significantly more powerful machines of the mid 1960s, so promoting close racing.

The new series will run alongside the existing Equipe GTS series, which has focused on smaller sub 2700cc-engined cars and attracted grids of 40-plus cars from the likes of MG, Morgan, Lotus and TVR. HRT

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ABOVE The Benjafield 500, a modern incarnation of the fastest race the world's ever seen

Magnificent 6 1/2 Litre Bentley storms Benjafield 500

Alan Stoddart

THE 2017 Benjafield 500 was held in October by the Benjafield's Racing Club at the Ascari Circuit in Spain, and saw a grid of 27 cars battling it out over the 500 mile race.

The event takes inspiration from the historic Brooklands events which were ran at the old English circuit between 1929 - 1937. The Benjafield 500, in keeping with tradition, is a handicapped event and as such allows a wide range of cars to compete on an equal footing. This means that a wide range of entrants, including a Talbot team car that actually ran in the 1931 Brooklands 500, are able to contest the event.

The history of the race stretches right back to 1928, when Dr J. Dudley Benjafield founded the British Racing Drivers' Club as a social club for British drivers to welcome drivers from overseas. The first event organised by the club was a 500-mile race at Brooklands in 1929. Slower cars set off before the faster cars, with all entrants aiming to complete the 500 miles in the fastest possible time. This fierce competition earned the race the reputation as being the fastest the world had ever seen.

This simple premise has been retained for the modern event. This year's race, which marked 80 years since the final race at the historic Brooklands track, saw victory going to Robert Abrey and Julian Riley in the 6½ litre Bentley with second place going to Martin Overington and Eddie McGuire in the 1929 Bentley Blower and third to Matthew Abrey and Robert Fellowes in the 1925 Bentley 3/4½.

"The Benjafield 500 is a fantastic re-enactment of a historic race that is as much a social event as it is a race," commented Chris Lunn, who organised the event. "It's about people coming together to celebrate an almost 80-year-old legacy all in the spirit of driving some of the greatest cars ever made. Benjafield's Club events are notoriously good fun, as you might expect for a club where entry is strictly limited to those who have done something either very good or very bad."

The Benjafield's Racing Club takes its name from the founding member of the BRDC and accepts a maximum of 100 members from around the world, all of which share a passion for vintage Bentleys, racing and for following in the footsteps of the Bentley Boys. The club exists to preserve the ethos and spirit of vintage racing and, in order to keep a mystique around the club, there is no known way of becoming a member. HRT



ABOVE Benjafield's events are notoriously good fun, as you might expect from a club where entry is limited to those who have done something either very good or very bad

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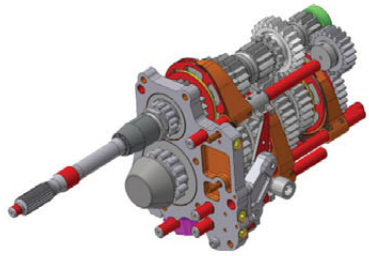
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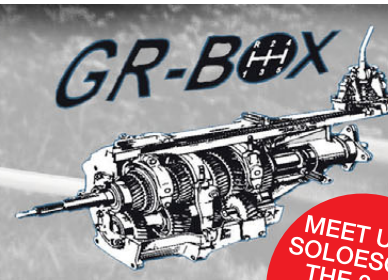
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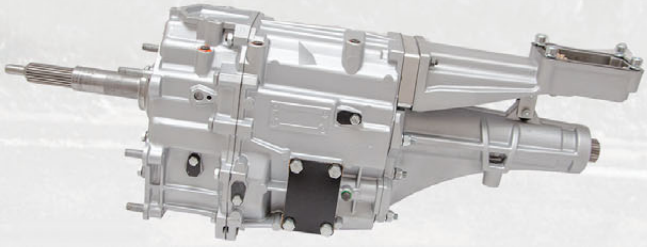
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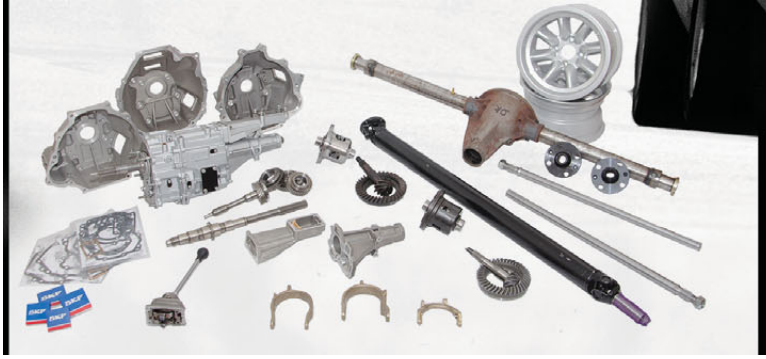
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NEWS

Duckhams oil relaunched at NEC Classic show

Andrew Charman

DUCKHAMS Oil, once a staple of motorsport, was relaunched at the NEC Classic Motorshow in November. Initially the company is offering monograde SAE30 and SAE40 and multigrade Q20w-50 oils for classic road cars, but intends to expand into motorsport and modern vehicles in the near future.

Duckhams was launched in 1899 by Alexander Duckham, an entrepreneur and engineer who accompanied Louis Bleriot on the first powered flight across the English Channel.

Known for its distinctive green colour, Duckhams became the dominant lubricant in the motor industry throughout the 20th century and also achieved many successes at the highest levels of motorsport. The company was acquired by BP in 1969 and the name dropped out of the market in the early 2000s as BP concentrated on the Castrol brand which it also owned. HRT



ABOVE The new Duckhams oil comes supplied in classic-styled cans.

IN BRIEF

THE Graham Hill Memorial Trophy is to be revived by the Mini Se7en Racing Club in 2018, and will be awarded to drivers aged under 17 competing in the club's S class for 1275cc cars with limited modifications. The move forms part of a young driver initiative at the club, which has seen entries in the S class reaching double figures in recent times.

THE 2018 Masters Historic Racing European calendar will visit two new venues. The eight-meeting season featuring up to five different series will include for the first time Imola in San Marino on 20-22 April and Most in the Czech Republic on 22-24 June. All five Masters categories will also feature on the Silverstone Classic timetable for the first time.

CAR manufacturer Aston Martin has joined the Brooklands Trust in funding a fully-functioning replica of the distinctive original scoreboard at the former Brooklands circuit in Surrey. The 12-metre high scoreboard was unveiled on 12-13 August during the Brooklands Reunion event. It forms a central component of the Brooklands Aircraft Factory & Race Track Revival Project that has also seen the moving of an aircraft hangar to open up the Finishing Straight of the original oval track.



GOODWOOD has announced the date of the 76th Members Meeting, which will be held on 17-18 March 2018. High-speed demonstrations during the event will focus on 1970s Group 5 sportscars and Formula 5000 single-seaters. Provisional dates for the Festival of Speed and the Goodwood Revival are 12-15 July and 7-9 September, subject to changes in the F1 World Championship calendar.

THE Historic Sports Car Club is to take over the organisation of the Super Touring Challenge, which caters primarily for the 2-litre Touring Cars built between 1991 and 2000. While initially attracting large grids numbers in the series have declined over the past two seasons, despite the addition of more classes for more recent cars. Series founders Dave Jarman and Jonny Westbrook will focus on promotion. HRT

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LAST OF THE BREED

Andy Swift examines two contrasting cars from the final days of the Group C and IMSA GTP movement, now restored to former glory



FEATURING carbon fibre monocoques, bubble canopies, sophisticated ground effect aerodynamics and towering power outputs, it seems hard to believe these aren't contemporary sports prototypes. Yet these machines are now 25 years old and the subject of a strong historic racing scene. Group C and its transatlantic equivalent – IMSA GTP – offer up the fastest historic racing in the world and a hugely diverse range of cars.

Midlands, UK-based Phil Stott Motorsport buys, sells, restores, repairs and prepares many of the cars competing in today's historic Group C movement. A glance around Stott's facility reveals machinery which begins with Brian Redman's Lola T600 – the car which had a terrific influence on the shape of the racers which succeeded it – right through to the stillborn Mercedes-Benz C292 of 1992. In between are examples from Jaguar, Toyota, Nissan, March, Argo, Spice, Lola and Intrepid. Many of the cars are on the button and ready to race, with others in varying states of restoration.

Among those now at the end of that process are two of the less celebrated machines from the final days of the Group C and GTP movement: an Intrepid RM-1 and razor-sharp Lola T92/10. The former, a thundering car, competed Stateside between 1991 and 1993; the latter is a rare specimen from the so-called 'atmo' period when Group C moved to 3.5-litre engines after a decade of unlimited capacities and turbochargers.

IMSA GTP INTREPID RM-1

The Intrepid was the brainchild of father and son duo Bob and Bill Riley, with funding from Jim Matthews. The basic concept of the car had been sat on the Rileys' drawing board since the mid-1980s, just awaiting the right benefactor. The design sought to make maximum use of the category's aerodynamic regulations, with cavernous venturi tunnels displacing all components in their wake, including the Penske dampers which perch in-board and horizontally, mounted high in the chassis as a result.

The quest for maximum downforce lent the car a distinct, boxy appearance, with a chiselled nose and flat sides; the effect was amplified by rear wheel spats. The result was a platform which purportedly bestowed the car with up to 4,000 kg of downforce – understood to be way beyond the potential of the Intrepid's rivals when it was introduced in 1991.

The car immediately became among the very fastest GTP runners. Wayne Taylor scored an early-season win at a wet New Orleans but that would remain the car's only IMSA victory. Tommy Kendall proved the design's credentials with top showings at Mid-Ohio and Lime Rock. At the latter circuit he lowered the lap record by a full two





ABOVE & BELOW The sleek Lola and snowplough-shaped Intrepid are from the same era, yet seemingly worlds apart Photos: Jeff Bloxham

seconds, revealing in a recent interview that it was the most satisfying racing car he ever drove.

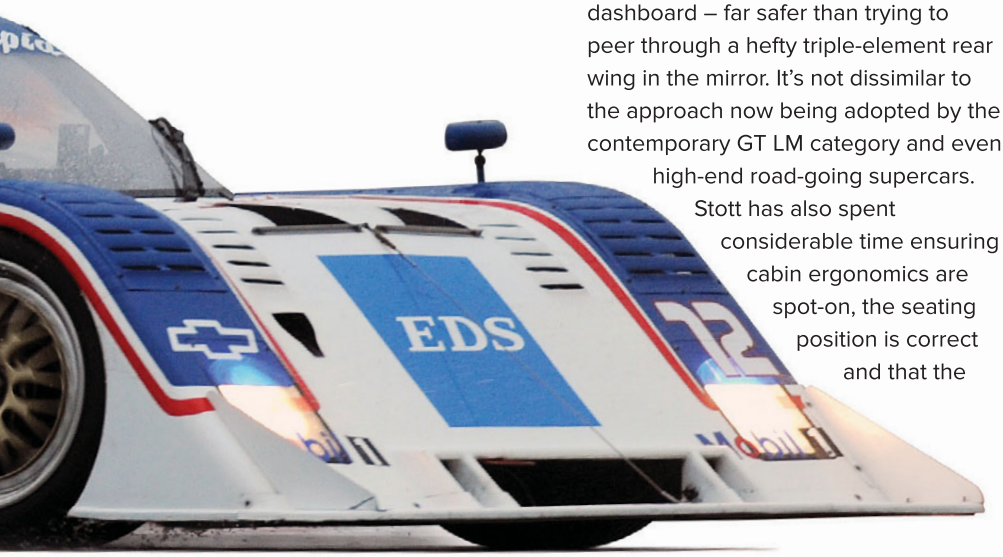
At Watkins Glen that season, however, Kendall suffered a monumental shunt which shattered his legs and feet, leaving him with permanent injuries. A hub disintegrated under the enormous cornering forces, leaving him a passenger as the car plunged head-first into the barrier.

Kendall returned to the cockpit the following season and his mount for that campaign, chassis #004, is undergoing light repair in Phil Stott's capable hands after a minor shunt at the 2017 Silverstone Classic, where the Group C races took place in horribly wet conditions.

Kendall cites the critical nature of seating and comfort in a GTP car, saying the correct seating position and belts enabled him to unlock the RM-1's almighty potential around fast circuits. Today, Stott describes that as his number one priority with customers: "The most critical aspect of the car is to get the driver comfortable and to ensure they are not moving around. As an extension of that principle, we have started using rear view cameras instead of mirrors. They can take some getting used to but once they've adapted, the drivers love them. The closing speeds between the professional and amateur drivers can be really big so the cameras can help them spot cars approaching rapidly from behind."

The camera system is a neat addition, with a small screen mounted on the dashboard – far safer than trying to peer through a hefty triple-element rear wing in the mirror. It's not dissimilar to the approach now being adopted by the contemporary GT LM category and even high-end road-going supercars.

Stott has also spent considerable time ensuring cabin ergonomics are spot-on, the seating position is correct and that the natural ventilation for the screen is sufficient to prevent it from misting up during wet weather competition.



In spite of its huge performance, the Intrepid remains a fairly analogue and refreshingly 'old school' racing car. The driver isn't bombarded with information in the cockpit but Stott sets up all his machines with ECU-driven alarms to warn of potentially catastrophic issues such as serious overheating or loss of oil pressure. While the works teams in period did much work on ECUs, particularly in the Group C fuel-limited days with the likes of Bosch (Porsche) and TAG (Sauber-Mercedes), today all of Stott's historics compete with MoTeC ECUs mapped by Frazer MacKellar of MacKellar Racing.

The MoTeC ECU requires a full new wiring loom and sensors, with locations and parameters usually kept as period: "Why reinvent the wheel?" as Stott asserts. For cars which have been in collections for a long period of time, this rewire will form part of a well-honed and generally prescribed rebuilding process which also involves new fuel tanks, replacement perishables and a full crack test of sensitive components by Nicholson McLaren.

All ECUs are policed by Group C Racing and its scrutineer worked in the category in period. The entrants, though, are relatively self-regulating and none of them wish to see the series turned into an arms race resulting in illegal traction ▶

control settings and the like. This mature approach from the competitors is refreshing but essential, especially in relation to the very last of the line Group C and IMSA GTP weapons as the FIA Historical Technical Passport cut-off date is 1990, meaning the Intrepid and its immediate contemporaries do not require an HTP.

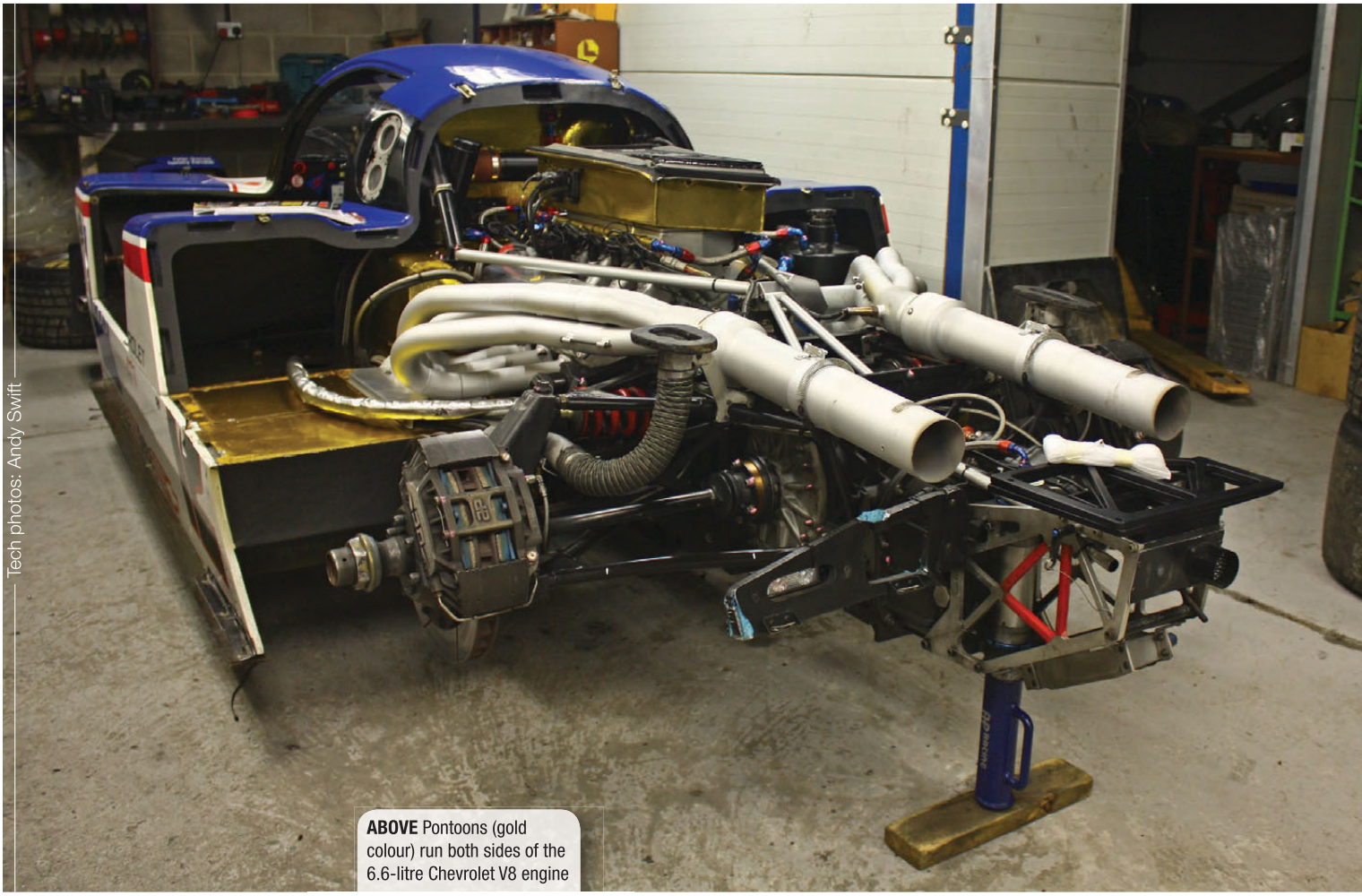
The Intrepid is blessed with a thundering all-aluminium 6.6-litre Chevrolet V8, originally produced by Katech. While the small-block V8's seismic soundtrack has become synonymous with the Intrepid, the car was initially conceived to house the Judd GV10 engine before IMSA intervened and prohibited 3.5-litre engines of the type used contemporaneously in the Sportscar World Championship. The story came full circle when Engine Developments Ltd (of which Judd is a sub-brand) rebuilt the Intrepid's motor on Stott's behalf as part of its restoration.

"The cam profiles are crazy – they look like they belong in a drag racer, not a circuit racer!"

The block is original but Engine Developments installed new heads with the camshafts matching the original, high-lift profiles. Stott is wide-eyed when describing the cams: "The profiles are crazy – they look like they belong in a drag racer, not a circuit racer!" Stott insists his engines should last two full seasons without a rebuild. That means running at around 7,500 rpm for the Intrepid; even in this rev-limited form it's good for 760 bhp, which puts it right in the ballpark with the competition. This is amateur racing and squeezing the last 15 bhp out of a stressed engine will lead to big bills – owners are often far better off chasing performance out of themselves than their power units.

That hefty V8 drives through a five-speed Hewland VGC gearbox controlled by a traditional H-pattern manual shifter. The car retains its original casing and Stott keeps most of his transmission work in-house, though major work is sub-contracted to John Pickford of JP Race at Silverstone. The team maintains a stock of different ratios and will change them from circuit to circuit. Stott says, however, that amateur drivers are less sensitive to minute ratio adjustments, so it's not a primary route for chasing performance with owner-drivers. All ratio records are maintained on a spreadsheet so they're easily accessed ahead of each event.

The Intrepid came to Stott with few spares so a stock has been built up over time. These are either fabricated in-house or subbed to specialists such as James Watt Automotive, ▶



Tech photos: Andy Swift

ABOVE Pontoons (gold colour) run both sides of the 6.6-litre Chevrolet V8 engine

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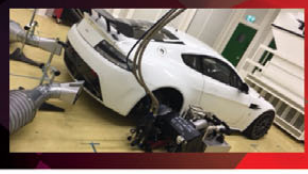
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Congratulations to Andrew Beverley for winning both the Peter Auto Sixties Endurance Championship and the HTC Group A Championship in 2017

Jeff Bloxham



ABOVE The RM-1 is characterised by the bluff, shovel shape of the body



ABOVE The original callipers are retained, but with steel brakes preferred to the carbon versions used in period



ABOVE The rear view cameras are safer than using the mirrors to peer through a triple-element rear wing

depending upon their complexity. At race meetings, the team would expect to carry a stock of spare driveshafts, CV joints, wishbones, rose joints, and proprietary items such as oil filters, pipes and fittings.

During HRT's visit, the RM-1 is undergoing a back-end rebuild after a brush with the pit wall at a sodden Silverstone Classic. The damage was confined to the rear left corner. The bodywork has been sent to KS Composites for repair and mechanically the car requires a new wishbone but has otherwise emerged unscathed. Stott will always seek to repair original parts rather than replace wherever possible – the authenticity of the cars is hugely important to him, even if he loves to see them in competition.

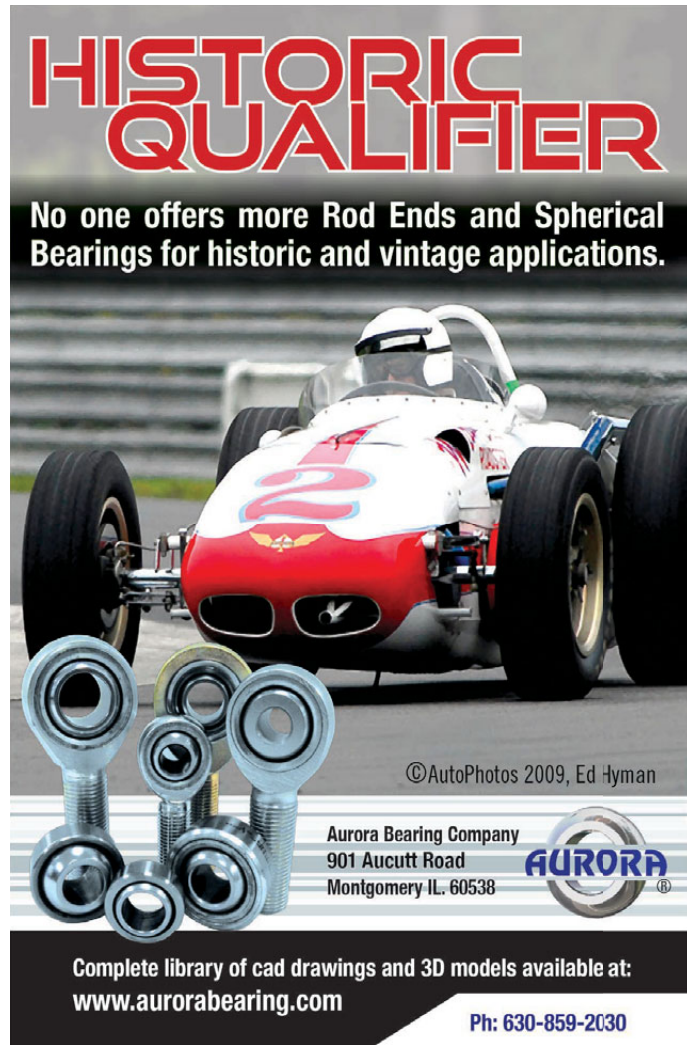
He claims that the Intrepid is an extremely user-friendly car on which to work. The vast ground effect floor can be removed with just six pins to allow access to the sump, though he cringes at the mention of the Intrepid's distinctive rear wheel spats: "They are a real nuisance and prevent quick pit stops to swap wheels during changeable conditions."

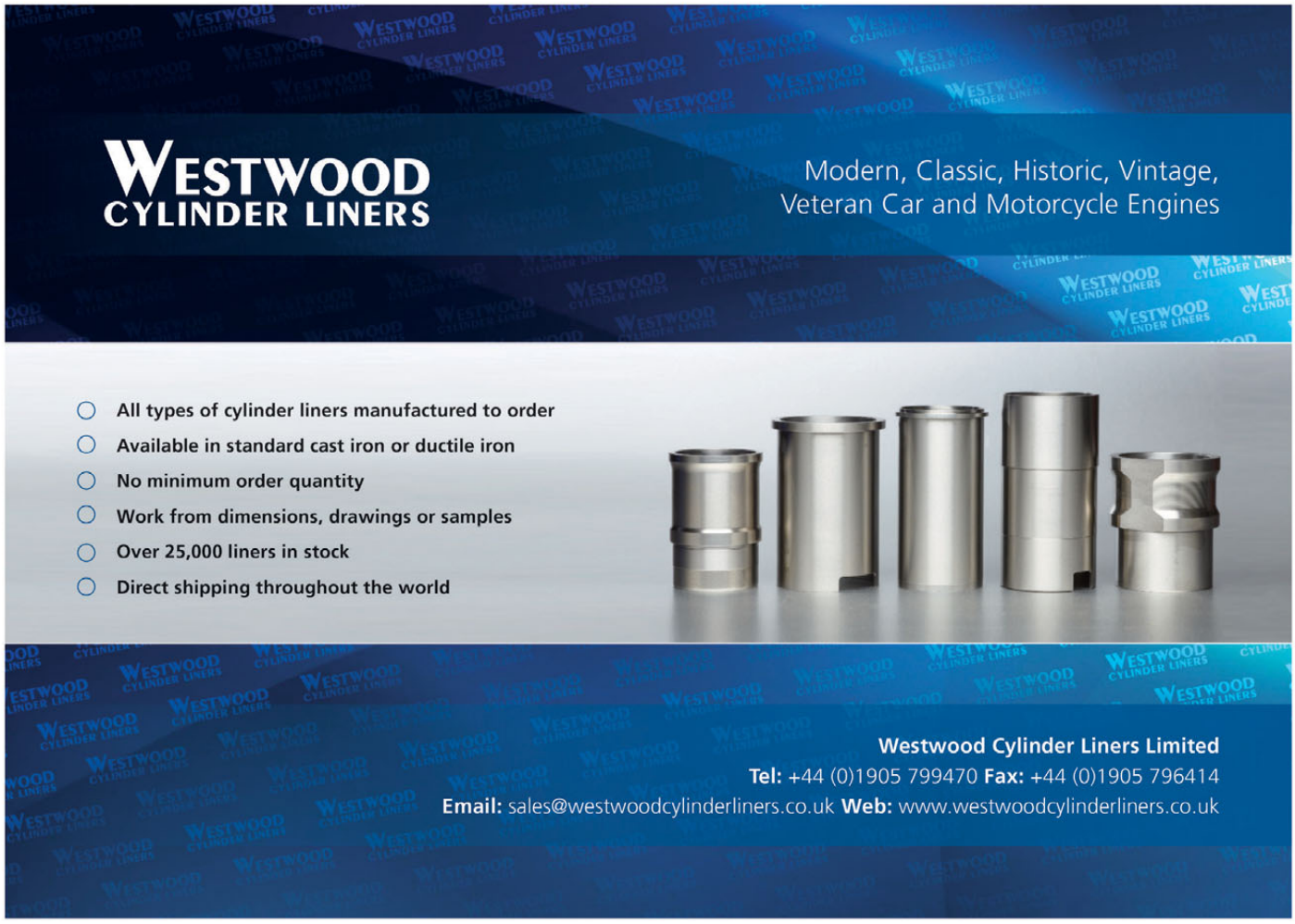
The Intrepid features a carbon fibre monocoque of a slightly unusual design. Rather than ending at the firewall behind the driver, pontoons run either side of the engine, from which is hung a lateral sub-frame which braces back to the bellhousing and carries the top-mounts for the horizontally-fixed Penske dampers. These pontoons increase the stiffness of the back end and reduce the amount of tubular bracing required in the engine bay, making the rear of the car easier to service.

The nature of the typical IMSA circuit of the time – think Watkins Glen, Miami or Lime Rock – was such that the American cars had developed with extremely high downforce and generally soft suspension settings to cope with bumpy surfaces and fast corners. This goes some way to explaining the Intrepid's extreme aero platform.

The team inherited a bundle of set-up sheets with the RM-1 and this enabled it to create a baseline for the car ahead of fine-tuning. While final tweaks will always be undertaken at each event, roll-out testing is most usually completed at Donington Park, close to the team's workshop, though Stott can cite occasions when he used Mallory Park during The Friendly Circuit's legendary unsilenced Wednesday ▶


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sessions. The mind boggles at the prospect of something like the Intrepid at full chat through Gerrard's at the top end of fourth gear...

The RM-1 permits plenty of scope for adjustment through both the aero and mechanical platforms. Today all cars in the category must run a minimum 60 mm ride height and this is controlled by fully adjustable Penske dampers which Stott inherited with the car. For smooth, wide European tracks like Silverstone and Paul Ricard, it's possible to run far stiffer spring rates than would have been possible in the States in period.

Front and rear anti-roll bars are fairly sophisticated units and adjustable from the cockpit. Each end of the ARBs features a flat steel blade which twists to adjust the angle of attack relative to the direction of suspension travel – and hence the torsion in the full unit. The whole item is beautifully engineered but made from steel, where the likes of Jaguar were able to use carbon fibre for their equivalents. This lack of exotic materials is perhaps one area where it is evident that the Intrepid did not have a major works budget behind it, even if General Motors supported the engine programme through its Chevrolet brand.

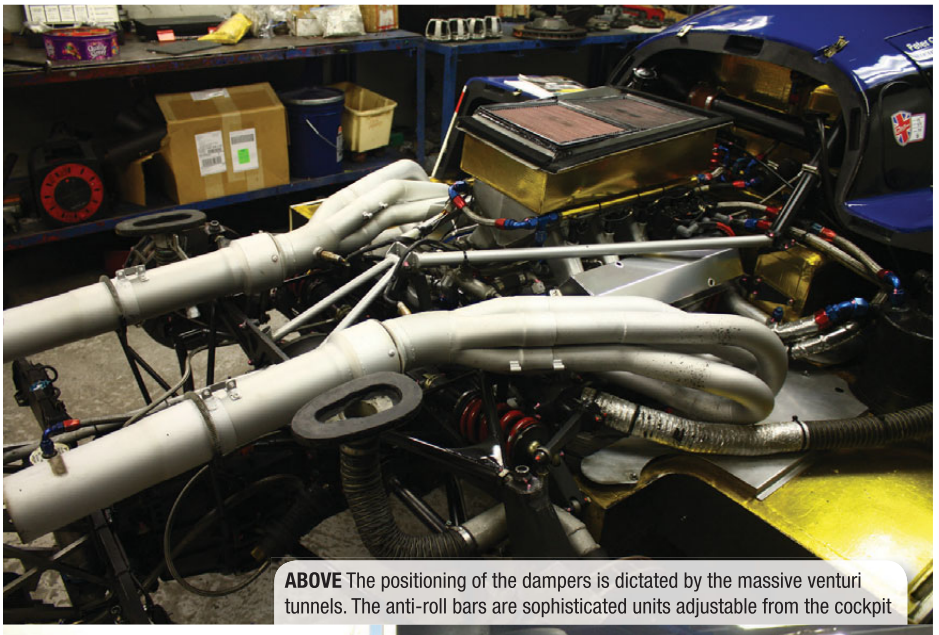
Perhaps unsurprisingly given its wedgey profile, the Intrepid is slower in a straight line than some of its European equivalents. Stott cites Spa Francorchamps as an example: where a Nissan R90CK might see 200 mph at the end of the Kemmel Straight, the RM-1 is topping out at around 180 mph. Still pretty quick for a 25-year-old racer, though.

The team is able to use the front splitter and vast triple-element rear wing to balance out the aero platform. As a general principle, the level of downforce will be trimmed out for professional drivers and maximised for amateurs. While the pros are happy on a knife-edge, creating a stable, predictable platform for the owner-drivers is more important.

Chassis #004 retains its original brake callipers but today runs steel discs, where in period carbon equivalents were employed. Stott is talking about returning the car to a full carbon set-up soon; a move which he advises will save around 35 kg in unsprung mass across the entire car – a statistic it is easy to believe when comparing the weight of each rotor straight off the workbench.

The carbon discs operate at significantly higher temperatures than their steel equivalents and that means replacing the aluminium pistons with titanium in order to dissipate all that additional heat. An AP Racing disc is available off-the-shelf and the replacements require no bedding in, though the imperative of getting them up to temperature makes them inherently tricky for amateur drivers to master.

Avon control tyres are the final piece of the puzzle and Stott retains a huge stock of them next to the unique Spice AK93, immediately behind the Intrepid in the workshop. Seventeen or 18" tyres are available, depending upon requirements, and each car is permitted two sets per weekend. These are barcoded and usage is monitored by the scrutineers to prevent a team trying to seek a competitive advantage. Tyre pressures can be tweaked by a couple of PSI for optimising set-up on a track-to-track basis.



ABOVE The positioning of the dampers is dictated by the massive venturi tunnels. The anti-roll bars are sophisticated units adjustable from the cockpit



ABOVE An extreme aero platform, aimed at generating maximum downforce, dominates the Intrepid's design

GROUP C LOLA T92/10

While Intrepid RM-1 chassis #004 was being used by Tommy Kendall during the 1992 IMSA GTP campaign, the Lola T92/10 chassis #HU1 was enduring a troubled season as the Group C movement ground to a halt. The T92/10 is a beautifully fashioned car, not far off true works levels of engineered integrity, and Stott can only shrug when questioned on how this level of engineering was funded as a privateer entry.

While the T92/10 did appear in virtually club-level Interserie competition after the death of the Sportscar World Championship, its contemporary career was limited to the 1992 season when Euro Racing ran Charles Zwolsman. He was one of the era's most fascinating entrants, even if for all the wrong reasons: he died in prison in 2011 having been convicted of drugs and firearms offences.

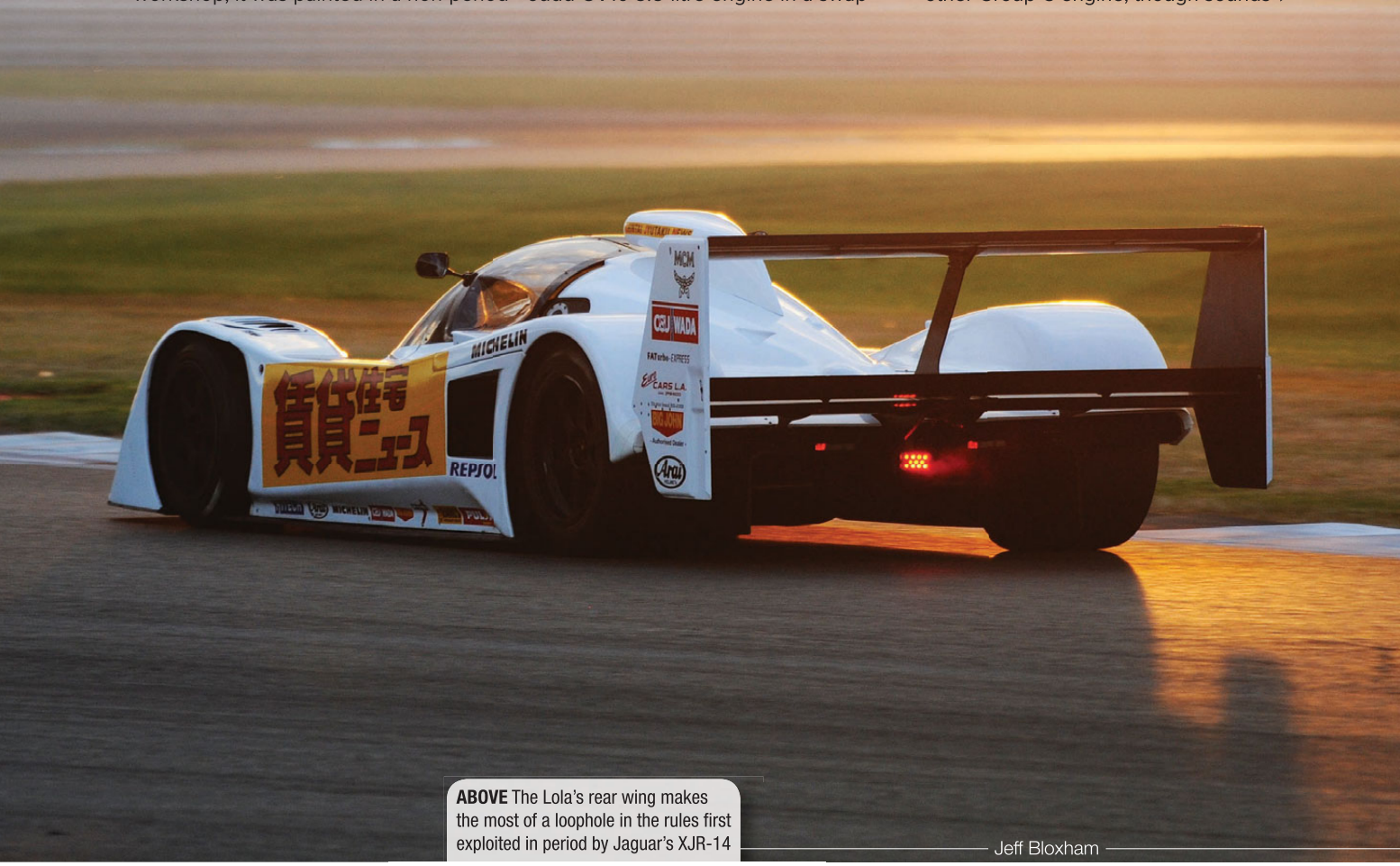
Stott helped broker the deal for Peter Garrod to purchase #HU1 a couple of years ago. When the car landed in the workshop, it was painted in a non-period black livery and hadn't run for perhaps 10 years. At some point, its original Judd GV10 motor had been replaced by a later four-litre GV4 unit.

Stott initiated a major mechanical and cosmetic restoration of the car in order to return it to its period glory. The livery work was undertaken by Lea Taylor, who recreated the Japanese-style graphics which reputedly are meaningless and were drawn simply for effect back in 1992.

Meanwhile, Stott had to search for a stock of genuine wheels, eventually finding two spare sets in Germany which gives the team a total of three sets. The T92/10 ran with bespoke wheels, embossed with the Lola logo and Stott maintains his stance of retaining the true aesthetic of all the cars he runs. He recently commissioned a batch of replica magnesium rims for Gerard Lopez's Jaguar XJR-14 after the originals were found to have deteriorated and become prone to cracking.

Fortuitously, Engine Developments was able to offer a genuine, period-correct Judd GV10 3.5-litre engine in a swap for the incumbent GV4. The GV10 was effectively a converted grand prix motor and could run up to a dizzying 13,000 rpm at maximum attack. Stott prefers an 11,000 rpm ceiling for longevity and maintains the same biennial rebuild regime for the screaming Judd as for the Intrepid's rumbling small block V8. Engine Developments undertakes that maintenance, just as it did in period for Zwolsman – a neat piece of synergy which reflects Stott's desire for authenticity.

The engine ran a Zytek ECU in period but has now been converted to a MoTeC 800-series unit, with the fuelling and mapping described as "perfect". The aural evidence from the 2016 Silverstone Classic certainly corroborates that statement: the Judd emitted that textured, hollow timbre so redolent of high-revving powerplants from the early to mid-1990s. In its current tune, the engine is developing 630 bhp which is plenty in a car weighing just 750 kg. Stott reckons it's as easy to run as any other Group C engine, though sounds ▶



ABOVE The Lola's rear wing makes the most of a loophole in the rules first exploited in period by Jaguar's XJR-14

Jeff Bloxham



ABOVE The 3.5-litre car's monocoque is a work of art

a note of caution over the potentially catastrophic effects of any failure due to the sheer number of revolutions at which the crank is turning.

With the obtuse livery applied to the sprint-style bodywork (tiny headlights nestling in the chiselled nose's extremities) and the requisite GV10 sourced, Stott undertook a full and sympathetic mechanical rebuild, following his usual principles. Radiators, coolers, pipes, Wiggins clips, perishable rubber components and the fuel tank were all replaced. Nicholson McLaren crack-tested hubs, suspension parts and the like – especially critical in a car of such potency. The installation of the MoTeC ECU required a replacement wiring loom.

Stott found the car remarkably easy to work on, especially given its awesome performance: "It's really the perfect customer racing car. In fact the only issue is the gearbox: it's quite involved to remove the geartrain so we can't perform any quick ratio changes between sessions." The gearbox internals are all Hewland proprietary components, but the casing is a bespoke Lola item and extremely rare, with nothing retained from previous Lola Group C efforts.

It quickly became evident that the stand-out feature of the car is its carbon fibre monocoque. Blessed with an abundance of complicated and intersecting curves, it's a true work of art, with neat scallops around the cabin to accommodate the gearlever, among other things.

Stott describes it as the most impressive chassis he's seen in any Group C or IMSA machine, including the hugely sophisticated Sauber-Mercedes C292, whose tub was manufactured by David Price Racing. The sheer quality of the carbon fibre is a testament to Lola's capabilities of the time but also raises once again the vexing question of how such artistry was funded.

Elsewhere, Stott found exotic materials throughout the car: titanium is used for the hubs, engine and gearbox mounts, and anti-roll bars. While he retains a stock of spare hubs, he visibly shudders at the thought of having to source or recreate new stock. Compared to the Lola-built Nissan R90CK (two examples of which sit in the workshop alongside the T92/10), it's highly evident that the manufacturer had to chase new avenues of weight-saving to hit the 750 kg limit imposed at the start of the atmo period in 1991.

At first glance, it's hard to conceive that the R90CK and T92/10 might be related but Stott points out a number of design carry-overs, such as the way airflow is channelled through the car, entering at a duct in the nose and exiting ahead of the rear wheels. In the turbocharged R90CK, this airflow feeds the intercoolers, while it performs the same task for the radiators on the later car. The glasshouse and aero packages are totally different and Stott confirms that HU1's tiny doors and exaggerated bubble canopy would be impossible to replace and extremely difficult to replicate. In terms of actual parts, though, nothing was retained from the R90CK for use in the T92/10.

The Lola runs the same mandated 60 mm ride height as the Intrepid, though actually runs a slightly softer suspension set-up due to its much lower weight. The cumulative effect of the weight saving is such that the Lola does without power steering, unlike its GTP equivalent. This lack of mass also makes the T92/10 extremely light on its tyres, particularly in mind of its high cornering speeds.

The Lola runs a deep, four-element rear wing which is blessed with a huge number of adjustment options. This type of wing was developed by Ross Brawn

for the all-conquering Jaguar XJR-14 and was unashamedly copied by every car for the following couple of seasons. Deep endplates and a beam wing at the same height as the rear deck effectively extended the vast venturi ground effect tunnels by another foot, offering outrageous downforce numbers and resultant cornering forces.

Having inherited no set-up data with #HU1, Stott was forced to use experience in initially getting a baseline set-up on the car. This was found to be really very good, with an optimum set-up for owner Peter Garrod established within a couple of test days. The angle of attack on the wings makes a big difference and more downforce could be sought by increasing the car's rake but the team has nailed down a set-up with which Garrod is comfortable.

At the track, running the T92/10 is, apparently, no more difficult than one of the myriad fuel formula Group C cars which have fallen into Stott's care. His attention to detail is visible in the blobs of pink paint on all the bolt heads which betray any cracking of bolts on threads. Fuel consumption is measured the old-fashioned, empirical way and the cars run without refuelling for safety reasons. The gearbox retains an H-pattern without complex hydraulic control systems and the rev limit on the screaming Judd has (touch wood) kept it as reliable and easy to run as less exotic predecessors.

Looking forward, Stott plans to continue with the Group C and IMSA GTP monsters which he so adores and isn't – so far – interested in the more recent machinery which is emerging for the nascent Masters Endurance Series for 1990s and 2000s sports racers.

As projects require it, he will continue to investigate new and emergent technologies. Nestling in the most distant corner of the workshop sit a Nissan P35 and Sauber-Mercedes C292. Both machines were stillborn and failed to compete in period but both should run again one day. Given their huge budgets, absolute absence of spare parts and exotic construction, he foresees rapid prototyping and 3D printing as obvious avenues for keeping these unicorns in operation. Meanwhile, the adoption of Racelogic and MoTeC 150-series ECUs offer new opportunities in terms of driver preparation and vehicle dynamics.

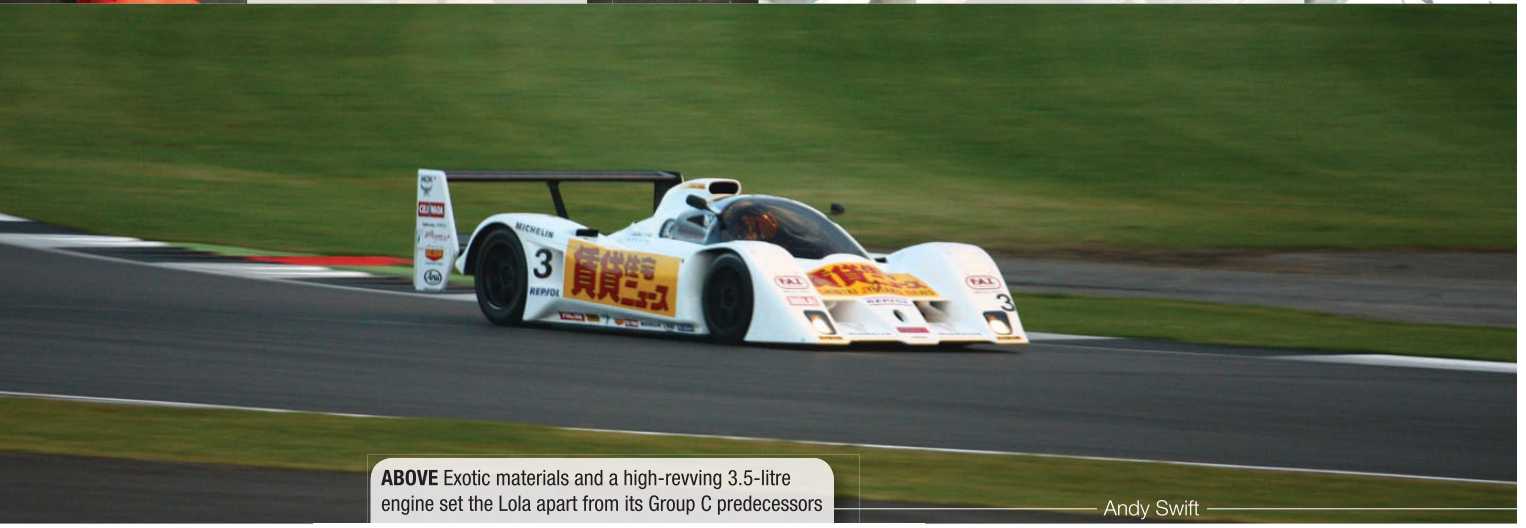
It's reassuring to see that the most evocative machinery of the 1980s and early-1990s is in safe hands and that proper, first-principles engineering remains at the core of its operation. Unlike in period, this isn't an arms race and new technology is being used primarily for safety and expedience, while enthusiastic amateur drivers chase pace in themselves. Surely, that's exactly how historic racing ought to be? HRT



ABOVE The installation of the MoTeC ECU required a replacement wiring loom



ABOVE HU1's tiny doors and exaggerated bubble canopy would be impossible to replace



ABOVE Exotic materials and a high-revving 3.5-litre engine set the Lola apart from its Group C predecessors

Andy Swift

ALL BETS ARE OFF!

Why the TVR Griffith is finally delivering on a wager made more than 50 years ago. By **Chris Pickering**



Jeff Bloxham

IT'S 50 years since the last of the original TVR Griffiths rolled out of the factory. Since then the name has been revived twice – most recently this year for the new Gordon Murray-designed car – but the original has undergone something of a revival itself.

Unlike some 1960s GTs, the TVR Griffith is one of the few cars that had as many racing in-period as now – mainly due to them offering a budget route to V8 power for the up and coming clubman racers. Today, however, they are achieving considerable success. Mike Jordan and Mark Whitaker hammered home that point earlier this year, with a dramatic victory over a field of E-Types, Ferraris and Cobras in the Graham Hill Trophy at the 75th Goodwood Members' Meeting. Spin forward a couple of months to Spa and one of its sister cars was consistently lapping within two seconds of the pace of the Ford GT40s.

To some these giant-slaying antics might seem incongruous. But delve a little deeper and the question is not so much why the TVRs have risen to prominence now, but why they often failed to do so in-period. After all, a Griffith is something like 100 kg lighter than the equivalent Cobra, with the same engine, less frontal area and a more sophisticated suspension design.

To find out more, we've come to speak to Nigel Reuben. He's a TVR man through and through, having worked in the factory's own competition department and then at marque specialist David Gerald Sportscars before setting up Nigel Reuben Racing in 1989.

"The Griffith is a really good package, but not a lot of people explored the car in-period," he explains. "They represent a great option for historic GT racing. They've got the performance to take on the Cobras and the E-Types at a fraction of the cost."

BORN FROM A BET

It's worth recapping on how the TVR Griffith was born. The car takes its name from Jack Griffith, an enterprising Long Island car salesman who had a penchant for British sports cars. He was a friend of Carroll Shelby and had even helped to ship the early Cobras into the US. The pair reputedly had something of a falling out, and that was when Griffith



BELOW The Griffith has emerged as a more formidable racer now than it was in-period

> **“They’ve got the performance to take on the Cobras and the E-Types at a fraction of the cost”**

bet Shelby that he could build a car that would beat the Cobra.

The recipe was very similar. He planned to take a TVR Grantura Mk3a – a small fibreglass-bodied sports car with a tubular steel backbone chassis – and shoehorn a large American V8 in place of the compact four-cylinder MG engine. TVR was all too happy to oblige and supplied Griffith with the body and chassis for the first car in 1963.

Initially, Griffith considered using the Buick 215 cid engine. Ironically, this all-aluminium V8 went on to play a major role in the TVR story after the design was bought by Rover, but that chapter wasn’t to begin for nearly another 20 years. Instead, Griffith’s mechanic Roger Teck persuaded him to use the 4.7-litre (289 cu in) Ford Windsor V8, just as Shelby had done with the Cobra.

The first three chassis were shipped to the States in standard Grantura form. The Griffith mechanics had to bend the upper cross member at the front to get the engines in (reputedly using a sledgehammer to do so on the first car). It was still a very tight squeeze, however, so TVR engineer David Hives flew out to Long Island and designed a revised chassis for the production Griffith 200. On these, the top tubes swell outwards ahead of the bulkhead to provide extra clearance in the engine bay.

Elsewhere, the wheel arches were flared to accommodate wider 185-section tyres that would give the Griffith at least a fighting chance of handling the Ford V8’s prodigious torque. A few extra vents were also cut in the bodywork to aid cooling, but that was about it; the standard MG radiator was retained, as was the MGB’s ‘Banjo’ differential.

EARLY ISSUES

The thinking behind the project was sound, but the execution wasn’t as polished as that at Shelby, let alone Jaguar or Ferrari. Early Griffiths were known to blast the Banjo differential straight out the back of the chassis, while they also suffered persistent issues with braking and engine cooling.

In 1964, the Griffith 400 was introduced. By this time, the car was being constructed on both sides of the Atlantic, badged as a TVR in the UK and simply as a Griffith in the United States. It now featured the 271 bhp Ford 289 ▶

HiPo engine that had been an option on the Griffith 200.

As standard, both models used the Ford Toploader gearbox from the Mustang and the early Cobra. However, this was quite a heavy unit and not especially strong, so TVR homologated the General Motors T10 transmission from the Corvette for racing use on the 400. It's virtually half the weight, yet almost a straight swap, so this continues to be a popular mod.

Perhaps the most significant change was the switch to a Salisbury 4HU differential, as used on the Jaguar E-Type. This is a much stronger unit ("It'll cope with 450 to 500 bhp quite easily," notes Reuben) and the mounting mechanism is far more robust. However, there was once again a packaging issue: the spacing of the rear chassis tubes had to be widened out to accommodate the bigger differential. These also serve as the lower wishbone pick up points, but fortunately it was possible to shorten the brackets just enough to maintain the geometry on the wider frame.

The later model also features revisions to the suspension. It retains the double wishbone setup front and rear – something of a novelty at the time – with TVR's own cast aluminium rear uprights and Triumph items on the front.



ABOVE The top chassis tubes swell out to accommodate the V8 engine

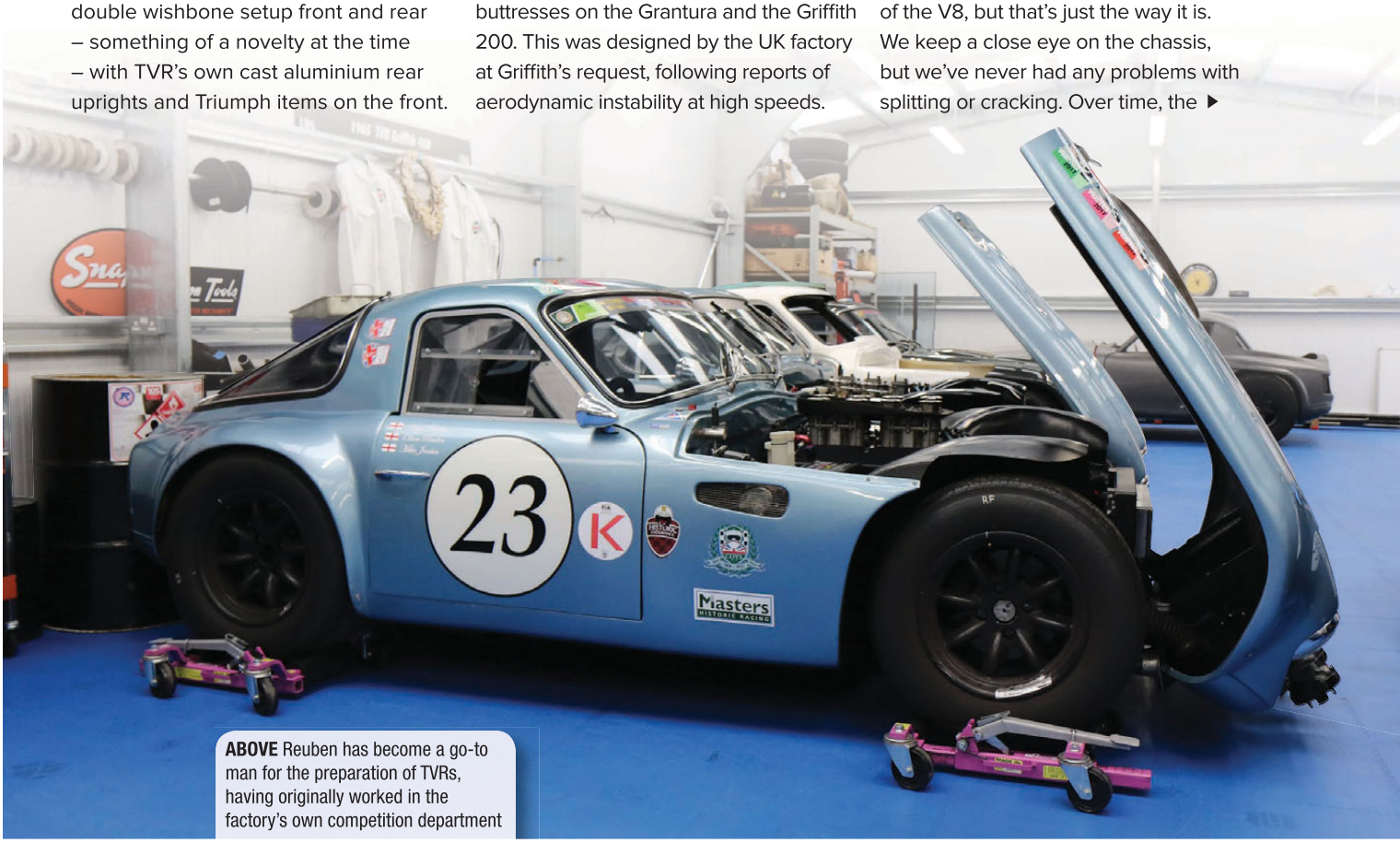
However, the original Triumph Herald lower wishbones at the front were replaced by tubular items all round, which increased strength and provided extra castor. Meanwhile, at the back, a second coilover unit was added to each wheel, giving a twin damper setup, with one either side of the lower upright mountings. This helps to improve the wheel control, giving the later Griffiths a bit more handling finesse.

Externally, the most obvious difference was the adoption of rather squat Kamm tail bodywork in place of the DB4-esque buttresses on the Grantura and the Griffith 200. This was designed by the UK factory at Griffith's request, following reports of aerodynamic instability at high speeds.

ORIGINAL FACTORY JIG

Nigel Reuben Racing holds the original factory chassis jig for the Griffith, as well as its own body bucks. Between the two, plus a comprehensive on-site fabrication capability, the company can virtually build a whole new Griffith.

For older restorations or those that haven't raced before, the first step in preparation is generally to fit a replacement chassis, Reuben explains: "The Griffiths flex more than the four-cylinder Granturas, due to the torque of the V8, but that's just the way it is. We keep a close eye on the chassis, but we've never had any problems with splitting or cracking. Over time, the ▶



ABOVE Reuben has become a go-to man for the preparation of TVRs, having originally worked in the factory's own competition department

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Jeff Bloxham

ABOVE Nigel Reuben Racing prepares two of the most notable Griffiths competing on the historic scene today

chassis and wishbones fatigue and lose their stiffness. We find they're ready for a refresh after about seven years of racing."

The fundamentals on the Griffith 400 are pretty good. It has plenty of power, a good gearbox in the T10, a strong differential in the 4HU and comparatively advanced suspension geometry for its era. In contrast, the biggest weak point is brake temperatures, he explains: "With drums on the back it's very difficult to find linings that will last. We've worked very hard with Porterfield in the US to develop a bespoke formulation for the rear shoes and we run Endless pads on the front."

The factory prototype 400 – chassis number one in the UK – did run rear discs in-period. As such, it is allowed to do so today, and it was this car that put in the giant-slaying performance at the Goodwood Members' Meeting. The others, meanwhile, are stuck with 10-inch MGB rear drums.

"The only downside to this car is that you've really got to nurse the brakes. You can race for up to about 45 minutes flat-out. If you're in an endurance race you have to pace yourself, though. At Spa, for instance, we can run at between 2:53 and 2:56 and still maintain the life of the pads," he comments.

Getting the suspension to work well is rather more straightforward. Under the FIA GTS regulations, the teams are limited to single-adjustable dampers. Reuben runs oil-filled steel-bodied Konis, just as the teams would have done in-period. However, the company has worked with the damper manufacturer to develop its own valving, which is applied to both the road and race cars.

Perhaps surprisingly for a car with such a hairy-chested image, one of the Griffith's biggest strengths is actually its traction, he explains: "If you can control the position of a car behind you under the brakes you can more or less guarantee to be faster out of the corner. Coming out of somewhere like Surtees on the Brands Hatch Grand Prix circuit you can pull 10 or 15 lengths on the car behind, just on traction. They'll gain it back under braking into Westfield, but then you'll get it back again." ▶



BELOW A twin damper setup offers the later Griffiths a bit more handling finesse

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ABOVE Reuben's experiments have extracted a bit more power and a distinctive sound from the exhaust system

Part of the secret is getting the right differential settings. The Griffith doesn't respond especially well to aggressive locking characteristics. Instead, Reuben runs a standard Salisbury-type limited slip differential with a relatively light pre-load.

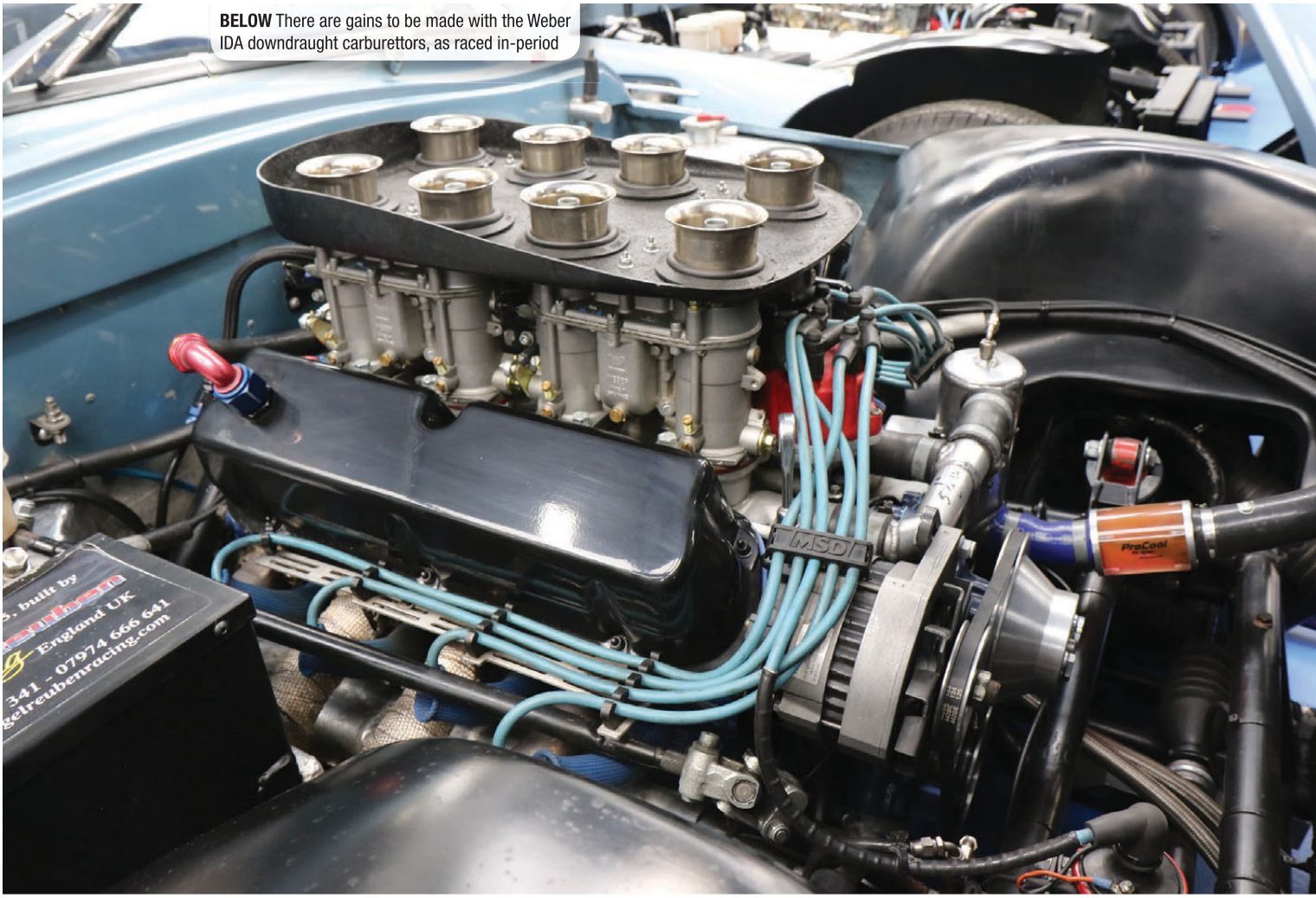
"We have experimented with modern differentials, but they're just far too aggressive," he explains. "They work well on cars like E-Types with a longer wheelbase, but they don't suit the Griffith's layout."

You might expect all that torque to create reliability issues, but the Salisbury differential has proved more than up to the job. For long distance races, such as the Spa 6 Hours, the cars often run a differential oil cooler, but apart from that it's a standard setup. Griffiths did have a reputation for breaking driveshafts in-period, but that too has been cured. Reuben uses Bailey Morris items built to the original design, but in a modern material that's stronger and less brittle.

The final piece of the puzzle is the wheels themselves. Reuben uses Compomotive ML alloy wheels, which are in very similar style to the Minilites the TVRs were supplied with in-period. Over the years, however, he has worked with the wheel manufacturer to develop a special set of offset dimensions. It's this sort of attention to detail and a deeply ingrained knowledge of the marque that has made Reuben the go-to man for racing Griffiths.

COBRA-KILLER

Although the production cars typically used the standard 271 bhp Ford HiPo crate engine, TVRs have been running big power for a long time. Back in 1965, TVR dealer David Plumstead built a Griffith with a full-race GT40 engine, good for around 450 bhp; also equipped with four-wheel discs and 9-inch wide wheels, it became known as the Mongoose due to its ability to kill Cobras. ▶



BELOW There are gains to be made with the Weber IDA downdraught carburettors, as raced in-period

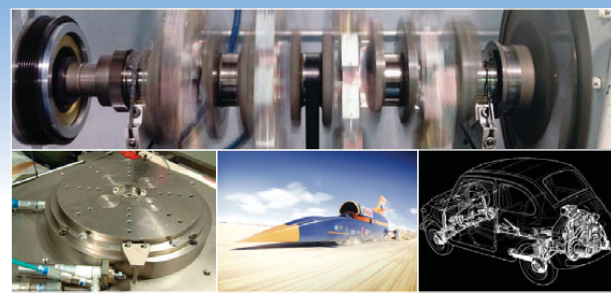
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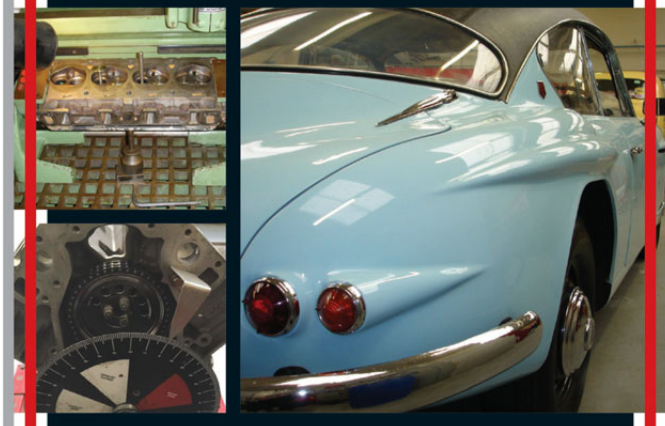
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13 X 8.0	-13 TO 17	97 TO 127	4.4 TO 5.0
13 X 10.0	-38 TO -08	97 TO 127	5.3 TO 5.9

SIZE	OFFSET RANGE	C DIMENSION (BACKSPACE)	APPROX WEIGHT KGS
13 X 5.5	-17 TO 13	60 TO 90	4.0 TO 4.6
13 X 6.0	-13 TO 17	73 TO 103	4.1 TO 4.7
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These days, Appendix K Griffiths run to a similar sort of power output. As with any historic racer it's a question of cumulative improvements in materials technology and understanding. The FIA homologation allows the cars to run Weber IDA downdraught carburettors, as raced in-period, in place of the four-barrel Holley unit found on some examples.

"People are sometimes frightened about tuning IDA carburettors, but there's definitely more power to be gained. They are very simple to tune when you know how," comments Reuben. "Modern camshaft design is also much better and a lot of engine builders have taken a big leap forward over the last 15 years or so with cylinder head development."

The other big improvement with these production-based V8s over the years has been the materials. The original HiPo would rev to about 5,500 rpm, but with modern cranks, pistons and rods you can rev them to 7,000 rpm or more. Reuben recommends keeping it to around 6,800 rpm, however, which he says gives around 50 hours of running between major rebuilds, with a light refresh at 25 hours.

PERIOD CASTINGS

These rebuilds are typically carried out in-house although the initial engine builds are handled by V8 specialist Steve Warrior Motorsport. In order to simplify parts swaps, such as new flywheels, Reuben favours neutral balancing, for which he typically uses local firm Andrews Precision.

At present, most competitors using Windsor V8s – in Europe at least – still start with period castings for the cylinder block and heads. In the US there's a whole industry devoted to building these engines, but that tends to focus on the later four-bolt main cap design, which was never homologated for use in the Griffith. The trick is to find one that has never been re-bored, Reuben notes: "By the time you get to 40 thou overbore, the blocks tend to run a lot hotter. We very rarely have internal failures, but if something like a piston does let go we try to find another block."

The blocks have a tendency to develop air traps at the back of the engine, so it's vital that the cooling system is bled correctly. Cooling generally isn't a problem, though, he explains: "People often fit bigger radiators with deeper cores, but we actually favour a smaller

BELOW A squat Kamm tail bodywork was adopted

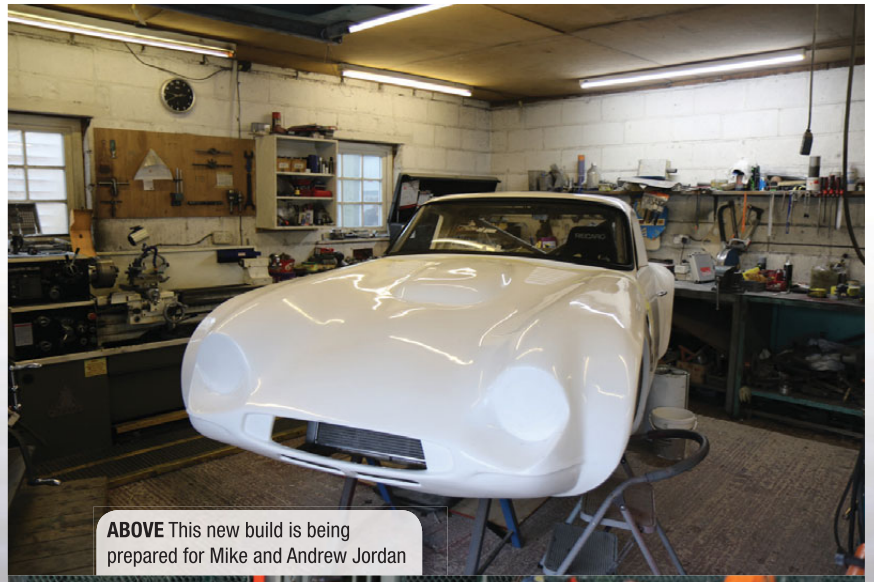


Jeff Bloxham

radiator with a thinner core to improve the airflow. It gets hot a lot quicker, because there's a smaller volume of water, but it works better at racing speeds. We find the standard water pump is a good match for the increased engine speeds, so we don't even need to change the diameter of the pulley."

The Griffith's homologation requires it to use a wet sump, so Reuben uses an off-the-shelf sump from US manufacturer Canton. This features four trap door-style flaps arranged in a diamond shape to provide baffling through 360 degrees.

These days, one of the potential issues with a thunderous V8 is noise testing. The original Griffith exhaust system runs as two pipes down the centre of the car, with two twin silencers. In an attempt to reduce sound levels, Reuben experimented with a collector system that feeds both sets of headers into a central silencer and then continues as a single pipe on to a second rear silencer. Working with Tony Law Exhausts and OJZ Engineering he found some unexpected benefits.



ABOVE This new build is being prepared for Mike and Andrew Jordan



ABOVE Cobra-eater: Griffith's wager with Carroll Shelby has been upheld

EXHAUST THEORY

"When you've got a short car like this there isn't a lot of space to put extra silencers, so I came up with a theory that feeding the two banks into one would cancel each other out and reduce the amount of noise," explains Reuben. "We found that the diameter at the collector was very important to get the right balance between noise and power. Ultimately, it seems to have given us a bit more power and it has resulted in quite a distinctive sound."

That characteristic roar is becoming an increasingly familiar presence in historic racing, with more Griffiths competing than ever before. Half a century on, it seems Jack Griffith's wager to Carroll Shelby has been upheld. HRT

SHOWING ITS TRUE COLOURS

Benetton's F1 cars from the early nineties are best remembered for their iconic liveries, but as **Alan Stoddart** finds out, there is a little more to them than that

As is the case with so many things, it is the small details that are often the most interesting. Look into the cockpit of the Benetton B190 that won the Japanese and Australian grands prix in 1990, and you will see a beautifully grained wooden gear knob, incongruent among the hard-worn carbon fibre weave and utilitarian switch gear that encased Nelson Piquet on the way to his first win of the season. The reason for this oddity is wonderfully simple: Piquet just preferred the way that the resonance of the car's engine felt through wood compared to metal.

And what an engine. Although down on cylinders compared to the V12 Ferrari 641 driven by Alain Prost and Nigel Mansell, and the Honda V10 of Ayrton Senna's McLaren MP4-5, the smaller, lighter Ford HBA4 engine of the Benetton meant that the car could run less downforce and was gentler on tyres, balancing out the difference in power compared to its rivals.

The HBA4 was made by Cosworth during the time it was owned by Ford, as such there is no actual Cosworth branding on the block itself. In race trim the 75-degree 3.5-litre V8 revs to 13,000 rpm and can put out as much as 680 bhp, but in the demo trim which it is now usually run, that is brought down to 12,500 rpm, which means the engine only requires a complete rebuild every 1,500 miles instead of every 1,000. At each one of these rebuilds, when the engine is entrusted to one of a select few companies – Langford Performance Engineering in Wellingborough, Nicholson McLaren in Wokingham, or Cosworth itself – it is completely stripped down and the pistons, bearings and spark plugs, as well as the fluids, are replaced. At every other rebuild, all the valves are also switched out.

The car's owner, John Reaks, says that Cosworth parts are always used to rebuild the engine. He explains that as well as keeping it original, he reckons



they are also the best parts for the job. "Cosworth developed their pistons especially for this engine, they did a lot of development work. So I only run Cosworth pistons in it," he says.

BRINGING IT TO LIFE

Firing up the engine is an art in itself, due in part to the tight tolerances to which it was made and the subsequent potential for wear when cold. First, hot water is pumped around the engine until it reaches 40 degrees. When this temperature is reached the ignition is turned on, and then the engine is cranked over until the oil pressure reaches 20 PSI. Next the level of the Mobil 1 fully synthetic oil used by Reaks is checked – one of several critical steps in protecting the engine. After this the fuel pump can be put on and the engine fired up. This, however, is far from the end of the process.

When the engine is started, it is run at about 3,000 RPM, which is about idling speed, until the engine temperature reaches 60 degrees. During this time Reaks emphasises that the throttle can't be touched, because this would only serve to wash the bores. With the engine running smoothly at 60 degrees, the revs can be increased to 3,500 RPM, at which point the alternator is charging at something over 12 volts. Additionally, turning it at a reasonable speed helps to flick the cams over and stops too much load being placed on the valves. Running at this speed the engine should reach 80 degrees very quickly, at which point it is ready to go.

It is still not fuelling equally on both sides of the engine though. Because the HBA4 is designed to run between 9,000 and 13,000 RPM, even at 6,000 RPM fuel pressures are different on either side of the vee. Reaks says that these fuelling differences are especially noticeable when the engine is on the dyno. The pump is "chucking" fuel in, but without the airflow from the scoop ramming the fuel down, the petrol is spat up and puddles everywhere.

The B190 is able to run on super unleaded fuel, which is treated with Millers CVL to lubricate the valve seats and boost the fuel by about three octane, helping to avoid knock. Originally, the fuel was stored in a 200-litre cell, which was necessary given that the car competed when mid-race refuelling was not allowed. Now however, the car has a 100-litre tank made by ATL, which fits behind the seat. The tank has backwards baffles which trap the fuel during acceleration. At the back of the cell is a collector which is always full and prevents fuel surge as a result of the significant G-forces acting on it. This has two low pressure pumps diagonally placed at the front and rear, which again ensure that whichever way the car is moving there is pickup and the engine isn't starved. These low pressure pumps feed the high pressure pump, which pumps the fuel to the discharge and on to the fuel rail. ▶



ABOVE The B190's career came full circle when Reaks returned the car to Suzuka, scene of its first victory

Fuel connections come out of the carbon fibre tub behind the seat. The engine and the entire rear end is attached to this lightweight tub by just three surprisingly small plates, which are about three by seven inches. There is one plate either side of the engine, and one underneath. If a crash severs the back end from the tub and the fuel lines are broken, a tether affixed to the engine pulls dry breaks, disconnecting the fuel line from the engine and sealing the fuel tank to minimise the risk of fire.

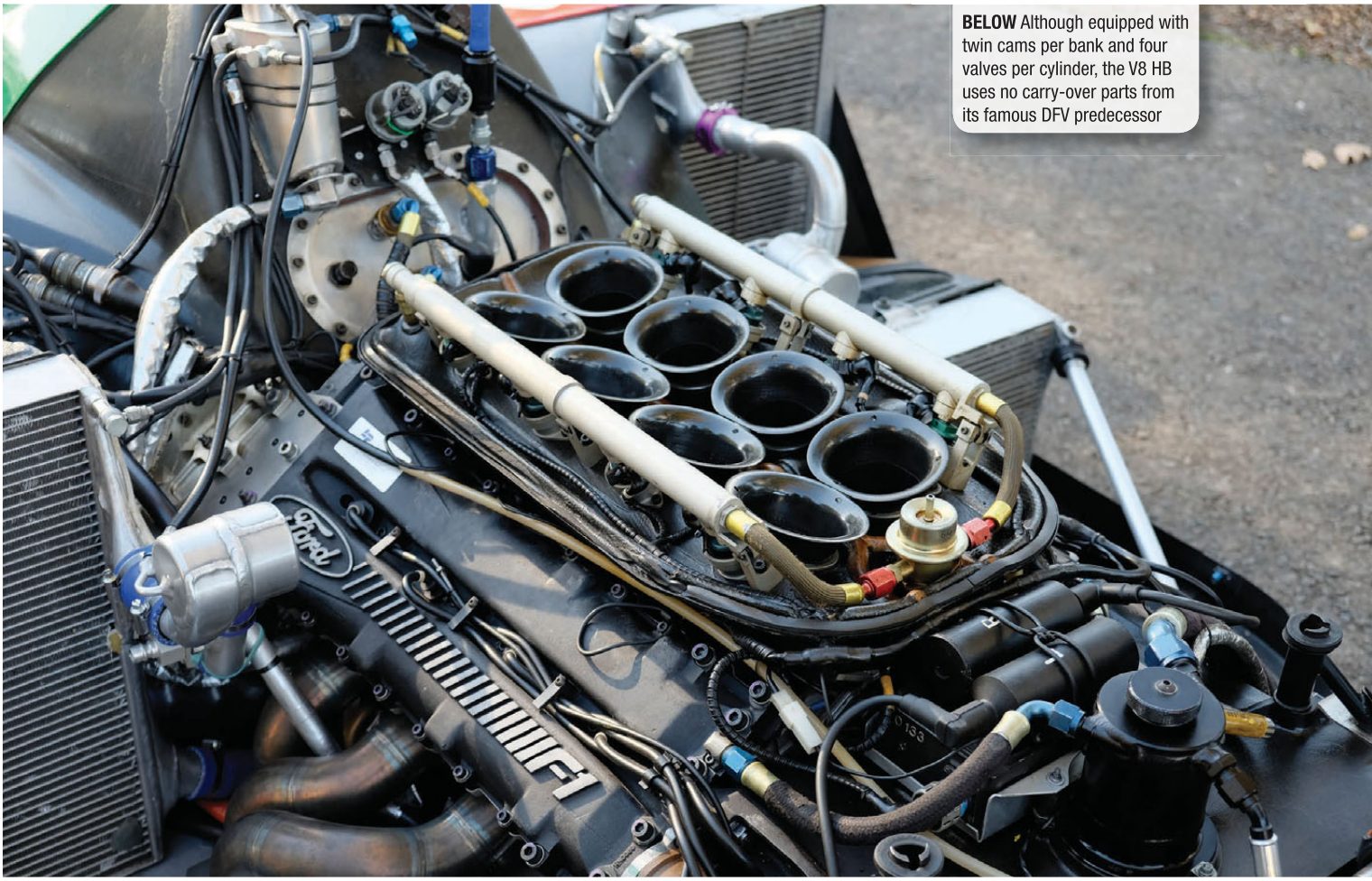
Fortunately, Reaks says he has never had the circumstance to put these safety systems to the test. Despite having the power to accelerate the 500 kg car to 180 mph in eight seconds, he says it's actually fairly easy to drive, particularly at lower speeds. This is helped though by having the rear anti-roll bar disconnected, which stops the ride being too skittish. The stiffness of the bar itself can, of course, also be adjusted when connected by switching out one bar for another depending on the desired suppleness of the ride. The choice of tyre also has an impact on the B190's ride.

Reaks chooses to wrap the original Speedline wheels in Avon rubber. "That's what we all run really," he explains. "It's a slightly more forgiving tyre. Other tyres might let you go fractionally quicker, but you'll end up in the barrier." The brakes are also crucial in controlling the car. AP Racing's Radi-CAL brake fluid helps the Brembo callipers securely grip the lightweight Carbone Industrie carbon discs. The discs themselves are increasingly rare as they are eight-hole, rather than the newer and now much more common 10-hole discs. These are mounted to wire-eroded magnesium hubs, which "cost a fortune to make". The wheel is then attached by a single nut tightened to an enormous 450 ft lbs.

> **"The original dash ran on DOS software but no-one has got the DOS program or the computers to run it"**

A DAILY DRIVE?

It isn't all plain sailing though. The Benetton B190, like several cars of the period, has its exhausts exiting though the car's diffuser. When on throttle, the hot, energetic exhaust gases speed up air flow through the diffuser which improves the venturi effect under the car and increases downforce without the side effect of more drag. The key phrase here however is 'on throttle'; as soon as the driver takes his foot off the accelerator pedal, the exhaust pressure is reduced which results in a subsequent loss of downforce. As such you approach a corner, lift off, change down, turn, and then, rather critically, ▶



BELOW Although equipped with twin cams per bank and four valves per cylinder, the V8 HB uses no carry-over parts from its famous DFV predecessor

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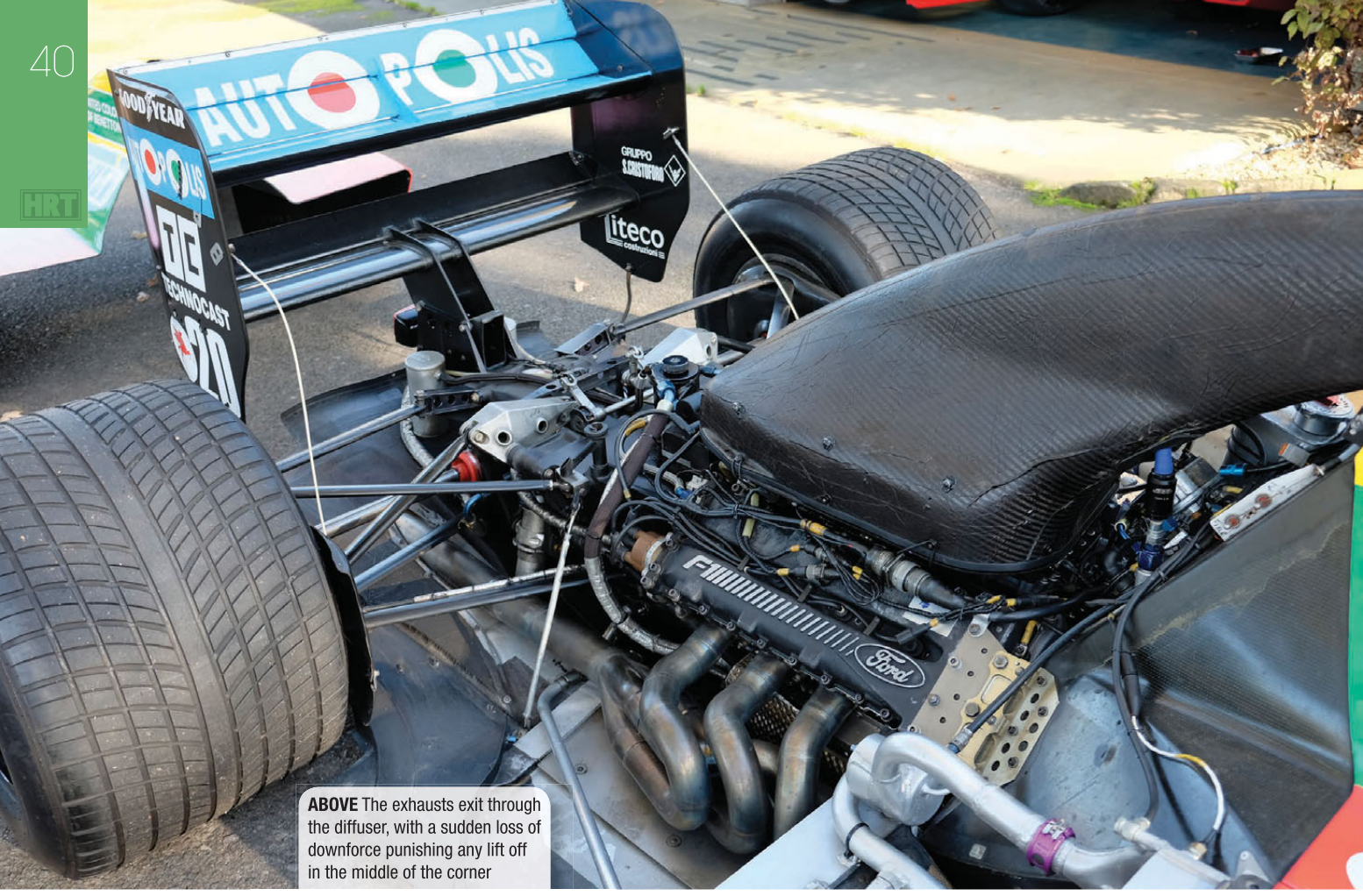
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ABOVE The exhausts exit through the diffuser, with a sudden loss of downforce punishing any lift off in the middle of the corner

make sure you keep accelerating through the corner because any lift off, particularly in a high speed corner, could result in quickly spinning out.

This isn't the only potential pitfall either. The steering rack is made from bore-drilled titanium. Most of the wear occurs on it on the straight ahead, which is the middle three teeth. If there is even the slightest wear on the rack, one of these teeth could snap off. If this happens when cornering, the whole thing jams and the car continues to turn corners that aren't there. As such it is one of the components that is checked before every outing to make sure it is still up to the job.

Other parts that you might expect to be problematic such as electronics, however, aren't actually too much of an issue. The ECU and spark box for example are all original. Of course, even if unused these parts have been sitting on a shelf for nearly 28 years. The joints have dried and instead of being soldered on, the legs of electrical components are just resting in the board, which means that as soon as there is any vibration at all, the contact is broken and the spark box doesn't work.

Somewhat fortuitously, Reaks knows a hobbyist who rebuilt two original spark boxes using period components. These rebuilds have done the trick. When they were tested by Cosworth, they wound up the engine all through the revs. "The sparks were jumping about a one-inch gap," he says. "It's such a powerful component."

Dashes are another matter however. "The original dash is never run by any of the people like me that run the Benettons... Everybody runs the Cosworth Pectel P1 dash," explains Reaks. "You couldn't run the Stack dash because they all ran on DOS software, and no-one has got the DOS program or the DOS computers to run it. Everyone converts it."

However, Reaks does have an original rear carbon casing, which took the original Stack electronic dash as well as two gauges. With this he is hoping to rebuild a modern day equivalent. He plans to approach Stack, which he hopes will be able to use the signals from the car to reverse engineer a new dash that replicates the original. He is also talking to people that were part of the Benetton team in order to get the details as close to the look of the 1990 car as possible. "I'm hoping to take the dash to an almost original state," Reaks enthuses. "That would be lovely."

THEN AND NOW

While 1990's Japanese Grand Prix at Suzuka is most frequently remembered for the first corner collision between Ayrton Senna's McLaren and Alain Prost's Ferrari, it was also the first race this Ford-powered Benetton B190 won. Piquet, who was driving the car, managed to keep his cool as rivals Gerhard Berger and Nigel Mansell succumbed to problems, and comfortably took the car to the chequered flag ahead of his team-mate Roberto Moreno. In the following and final race of the season in Adelaide, Piquet was able to use this car to repeat the success, claiming the win, taking third in the drivers' championship and in the process securing third for Benetton in the constructors' title.

Since then Piquet's B190 has changed very little. The original fire extinguishers, which are long out of date, have been replaced by a Lifeline model which meets FIA specifications and fits snugly below the seat. Reaks still has the originals, but they now reside in the garage among boxes of spare parts. These have proved invaluable, and enabled him to fit original spares which were also used by Piquet when there were problems.

It's easy to identify the provenance of these spares as they were all meticulously



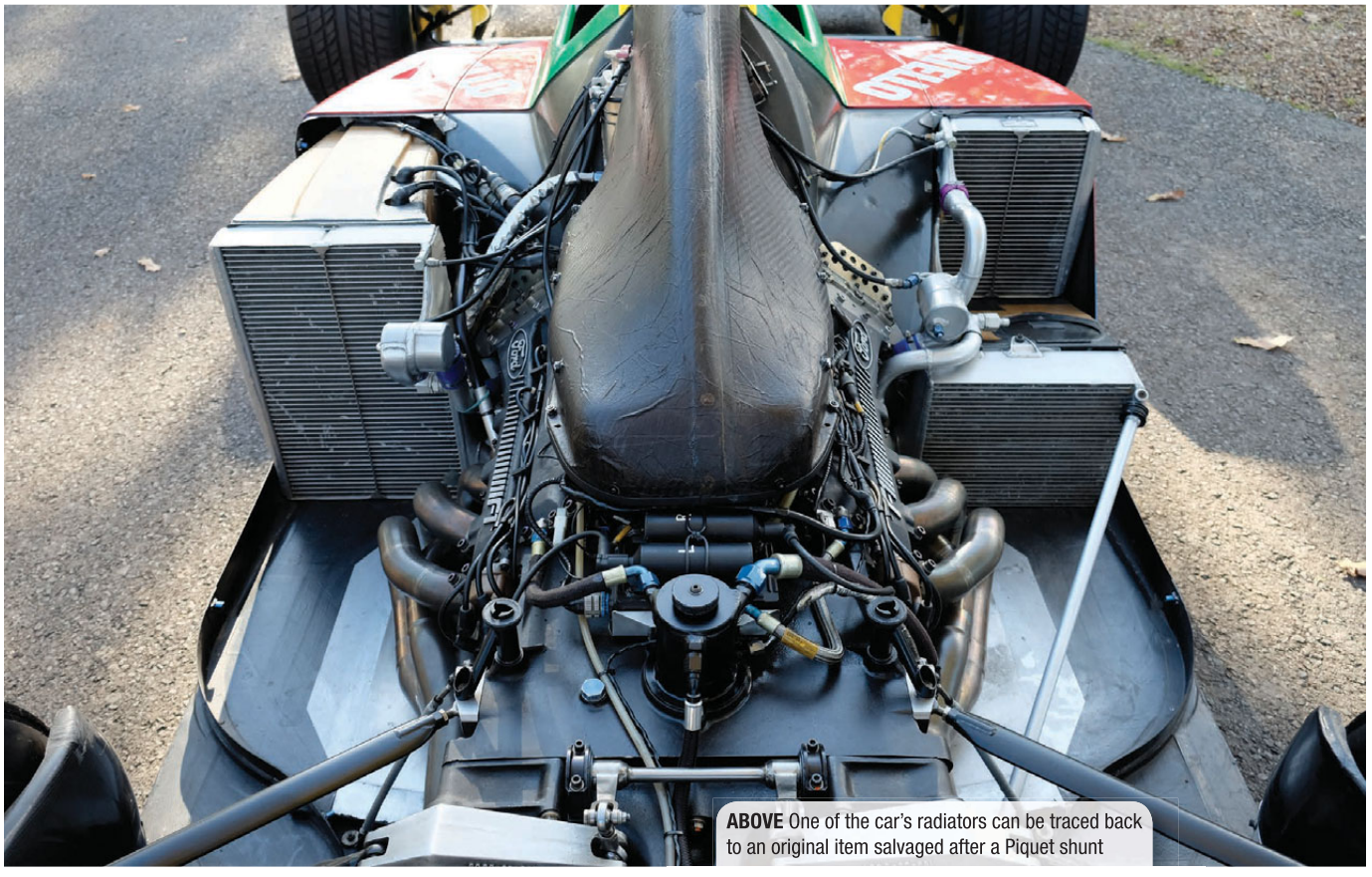
ABOVE The wooden gear knob is an oddity in the carbon-clad machine

numbered by Benetton. One of the water radiators that is on the car, for example, carries the number 190.10 D007 No. 4. The first digits, 190.10, refer to the section of the car where the part is located, and then D007 is the actual component identifier. Finally, every part is uniquely numbered, so the one currently on the car is part number four. Reaks says that this radiator, which he installed after the previous one developed a hole and was leaking heavily, used to have a sticker identifying it as one taken from a shunt involving Piquet, but indicated that it was 'pressure tested OK'.

Seeing a car like this today, away from the track, emphasises its focused, functional design. This becomes apparent in some of the details Reaks points out such as a bulge in the bodywork on the right side of the car. This small asymmetric protrusion is to accommodate a hand around that beautiful gear knob. Having to build in space specifically for the driver's hand demonstrates how much of a premium space is at and how every available inch is stolen in the name of performance.

This ruthless functionality permeates the entire racer, even informing things like the shape of the crankcase, which instead of being round is actually scroll shaped. This is so that less oil can be used, as oil isn't taken from the bottom to be recirculated, instead it is flicked up by the crank to a line of holes in the side of the case before being collected by three scavenger pumps. All of this is done to reduce resistance on the crank caused by oil. Other seemingly simple components also adhere to this focus. The outwardly straightforward aerosection pushrods, are actually quite complex arrangements of concertinas within an otherwise hollow interior to add lateral strength with the minimum weight penalty.

Details like this can only be seen and appreciated up close. Fortunately giving people the chance to experience and enjoy his car is something Reaks does passionately, regularly tracking it and even taking it as far away as Suzuka to run it on the circuit where it first found victory. These opportunities to see the iconically liveried Benetton flash by at full chat are something for which we should all be grateful. HRT



ABOVE One of the car's radiators can be traced back to an original item salvaged after a Piquet shunt

LIGHT HEAVYWEIGHT

The Chevron B8 punched above its weight in its day and just keeps on performing well. **Glen Smale** investigates what it takes to keep a B8 running

IT is fair to say that the Chevron B8 is not exceptional in any single area. Yet it is set apart by the manner in which its creator, Derek Bennett, combined all aspects of the car into an efficient package.

The story of the B8's constructor is an interesting one. A product of Bennett's fruitful mind, Chevron Cars grew out of his personal need for a better racecar. Having established himself as a repairer of racecars in the north of England in the 1950s, over the years Bennett got to understand first-hand how a number of different manufacturers set up their cars. His experience in this field led, through various evolutions, to the manufacture of the B8 Coupe which was introduced in 1968 and faced rivals such as the Ginetta G4, Lotus Elan and others.

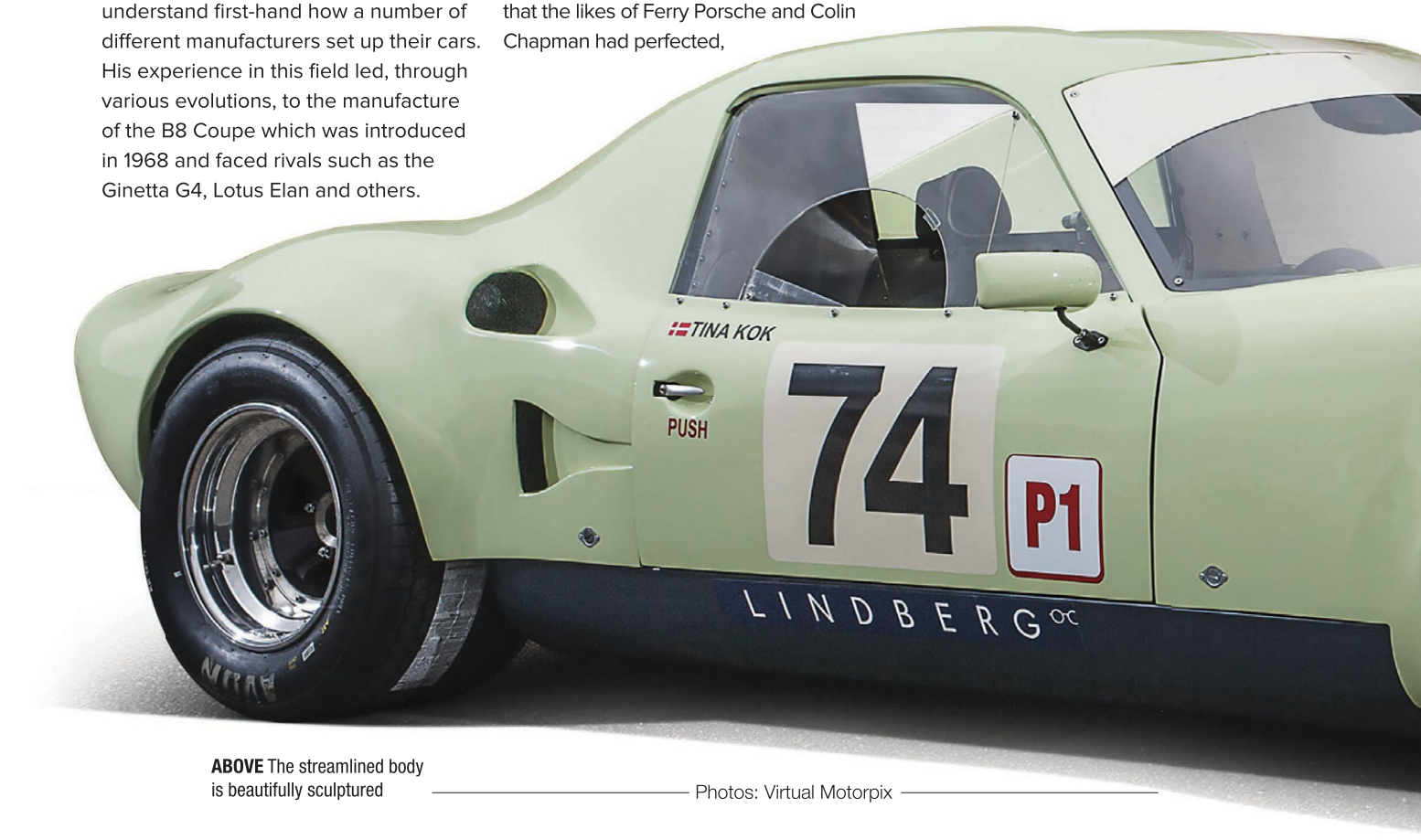
WHAT IS THE B8?

The Chevron B8 is a fairly simple two-seater racecar built on a spaceframe with a fibreglass body and with the engine located behind the driver, driven through a five-speed gearbox. That is a very simple explanation for what was a highly successful racecar, that punched well above its weight in class, and even shamed many rivals with far bigger engines. Through Bennett's work on his earlier models, he had followed the maxim that the likes of Ferry Porsche and Colin Chapman had perfected, with cars that were light and nimble and often referred to as 'giant-killers'.

Bennett's secret was simplicity in all quarters: a well-proven and reliable engine, a strong gearbox, and a package that included nothing that wasn't functional or necessary.

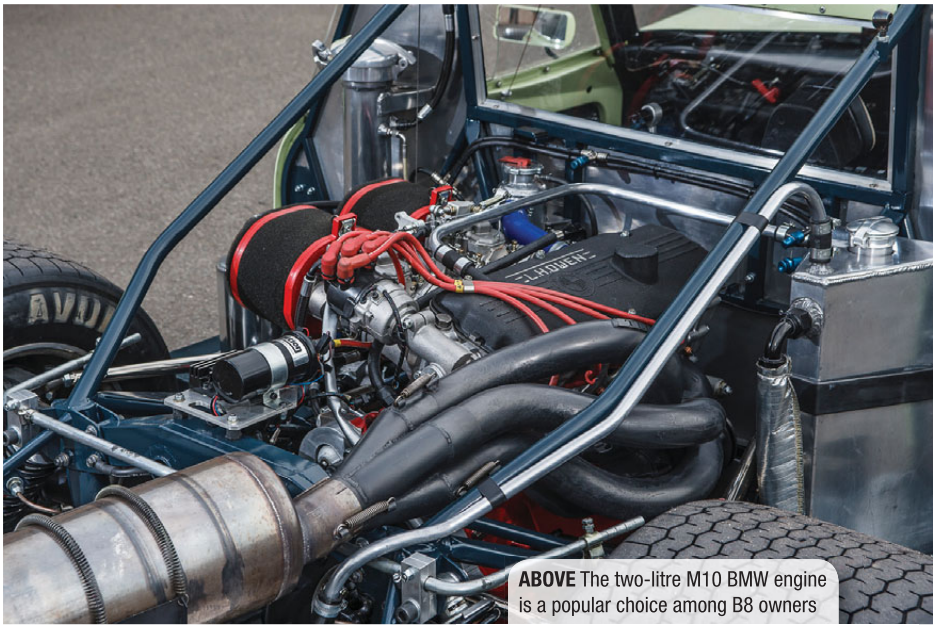
EARLY DAYS

The current owner of our feature car, Henrik Lindberg, acquired the B8 in 2015 and had it delivered to Paul Knapton's Xtec Engineering for preparation and maintenance. "When it arrived, it was in a race-ready condition so the very first thing we did was to take it for a shakedown test at Curborough,"



ABOVE The streamlined body is beautifully sculptured

Photos: Virtual Motorpix



ABOVE The two-litre M10 BMW engine is a popular choice among B8 owners

Knapton recalls. “This is a small local sprint track, and we went there just to make sure that everything was okay. From memory, everything was good, and there were no real problems at all.”

Following that first brief session, a more comprehensive test drive was set up for Lindberg’s wife and the car’s intended driver, Tina Kok, at Silverstone. “Because it was the first time that Tina had driven the car, Martin O’Connell went along to give her a bit of coaching,” says Knapton. “We did two tests but on the second Tina went off as she came out of Stowe corner at the end of the straight. The car spun round and went backwards into the inside barrier, so the back right was damaged.”

Besides a small dent in the driver’s pride, the right rear corner bodywork, a wheel rim, a couple of radius arms and a wishbone were replaced, the wishbone being fabricated by Xtec Engineering from 4130 tubes. One more test was undertaken at Donington, before the first race for Tina and the Chevron at Paul Ricard at the end of 2015.

MAINTAINING THE B8

Nestled neatly behind the driver is a two-litre M10 BMW engine. The unit, effectively the engine from the ever-popular 2002 production model, is by far the most common choice for the B8, as it is both proven and reliable. Today this 1991 cc engine will happily develop around 225 bhp at 8000 rpm with a torque figure of 168 ft/lbs at 6200 rpm, while running a compression ratio of 11.7:1.

“The racecars are quite basic from this period, but the engine is a fantastic little package,” says Ian Cox, managing director of WDK Motorsport, a Hampshire-based preparation expert with more than 60 different cars currently on its books. “The engine is coupled to a Hewland FT 200 gearbox, and that ‘box can run up to 300 bhp easily, so it is not stressed. And because neither the engine nor the gearbox is overly stressed, it is great for distance racing. Everything about the car was just right: power, balance and agility. That was Bennett’s mastery; he just had it in him. There were a lot of people that were better qualified than Bennett, but he just knew instinctively what the results would be if he made some changes, and that is why his cars are still great today.”

“Since we have had the car, we have had the engine rebuilt by Lester Owen, the guy who built it originally,” says Knapton. “After we had the engine rebuilt, we tested it at Pembrey Circuit in Carmarthenshire, Wales at the end of June 2016, ahead of the Classic Le Mans in July. We also serviced the carburettors, a pair of 45 DCOE Webers, when the engine went off to Lester.”

Owen has worked on many BMW M10s. “This engine, which was overhauled ▶



during the winter of 2015/2016, is the correct format for the [original] year," he affirms. "It still uses the original bore and stroke (89 x 80 mm) as well as conrod length, which is standard and original. The inlet valve diameter is 46 mm and the exhaust is 39 mm, which is also standard factory spec."

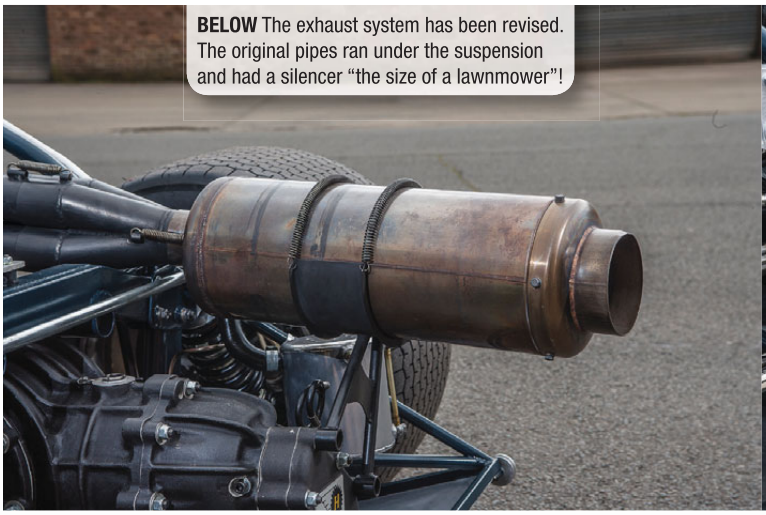
The crankshaft is the original design billet crank, but as Owen says, "It has definitely been replaced. The production crank in the original build was good for 8000 rpm, but eventually they would break." There was a time when BMW simply ran out of replacement cranks, and owners were forced to get individual versions manufactured by specialist engineering firms, but eventually they were put back into production.

When spectators watch historic racing today, they want to see the cars *racing*, not breaking down around the track. "These historic cars need to race," agrees Owen. "A lot of people believe that it is all about repairing them in the paddock; it isn't really. When you travel to the south of France for a race it costs a fortune, and you need to complete the race, so the cars have got to be reliable. And I think that is where historic racing needs to be."

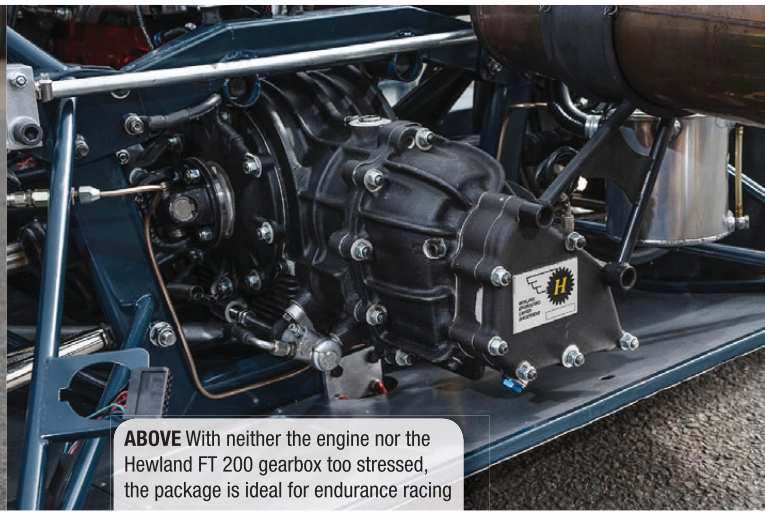
SILENCER "SIZE OF A LAWNMOWER"

Originally, the exhaust pipes ran down and under the suspension, and out of a hole in the undertray at the back. "It had a silencer about the size of a lawnmower and of course that didn't comply with noise limits. So, in order to get a decent silencer on it, we had to move the system out and over the top," Owen explains.

The Chevron runs a dry sump oil system

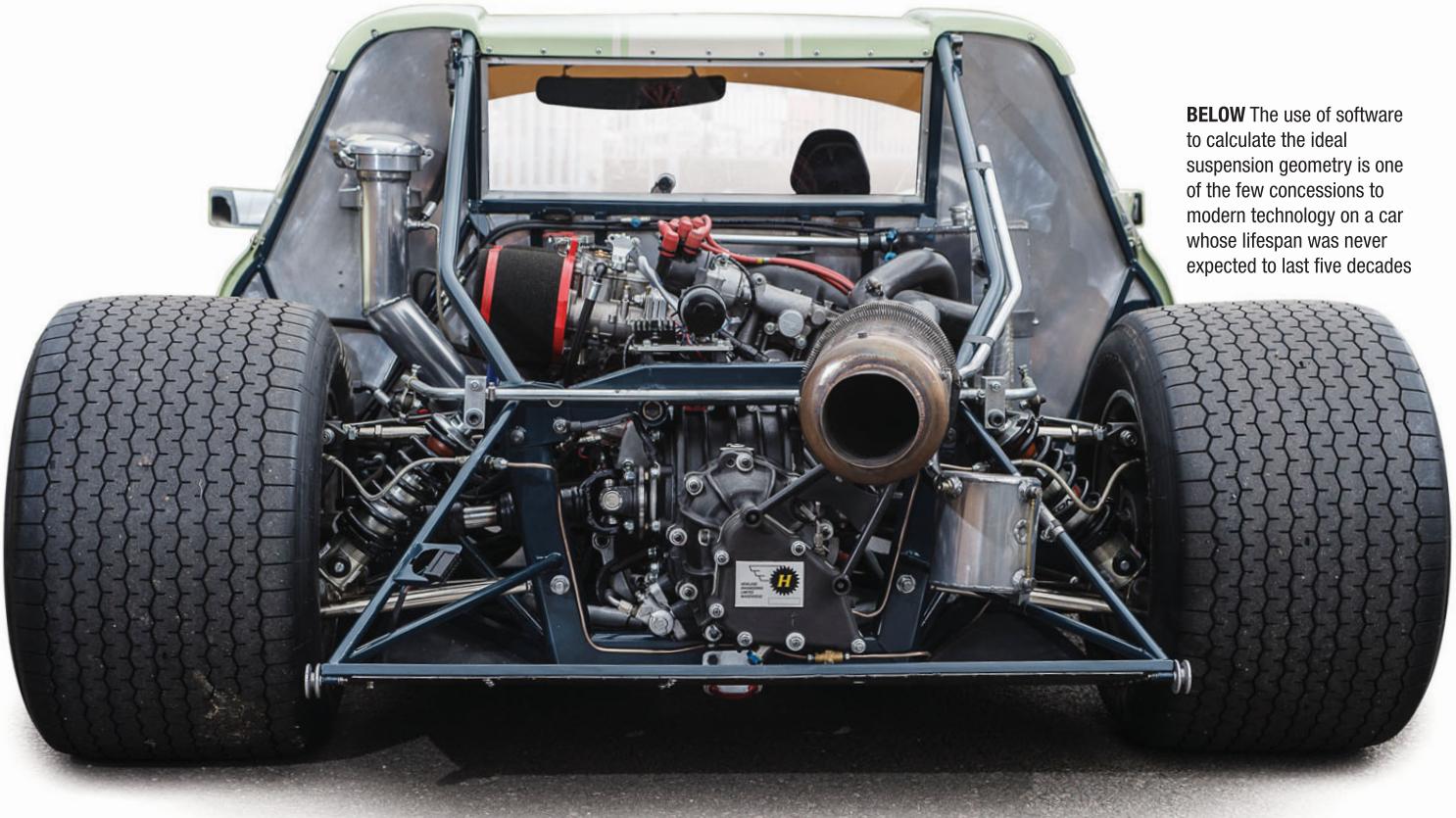


BELOW The exhaust system has been revised. The original pipes ran under the suspension and had a silencer "the size of a lawnmower"!



ABOVE With neither the engine nor the Hewland FT 200 gearbox too stressed, the package is ideal for endurance racing

BELOW The theory is that leaving the vertical rear panel open reduces the drag



BELOW The use of software to calculate the ideal suspension geometry is one of the few concessions to modern technology on a car whose lifespan was never expected to last five decades

and the tank sits on the firewall in the engine bay, directly behind the driver's seat. The oil system uses a Fram oil filter with Motul 1550/300V engine oil. The breather tank is located at the rear of the engine, close to the exhaust outlet. The engine breathes through a pair of Piper Cross foam air filters.

The Chevron B8 uses a double wishbone suspension setup at both the front and the rear, with coilover shocks on all four corners. The shock absorbers used are Koni 2810 which are produced by Ian Gardiner Racing, and over each shock is fitted a 2¼-inch ID standard Eibach spring.

The original uprights go back to the Triumph Herald, which most racing cars from that period would use. The Herald uprights served their purpose well, but Chevron introduced magnesium uprights for the works B8 cars, so this feature car was also converted to magnesium. "It has now got the magnesium works B8 uprights," confirms Knapton. "We bought them from Steve Sheldon at Red Rose Racing. They are our Chevron agents; it's where we have bought other suspension bits in the past, like wishbones."

Over the years, many other B8s have also replaced the original Herald steering rack that was used, with a more modern Titan unit. The logic behind

> **"He knew instinctively what the results would be if he made changes. That's why his cars are still great today"**

this can be clearly seen, because the production car unit was never intended for racing, and certainly wasn't up to the rigours of continued competition use. Also, when most racecars are designed and made, even today, they only have a useful life of a season or two at most. So, to expect a production car unit to go on performing beyond its operational envelope – which was at most a couple of years back in the 1960s/'70s – is stretching the point a bit far. Back then, it was probably never imagined that 'historic racing' would extend the life of a racecar for up to five decades.

If there is a factor that counts against the B8, it is that they were so simple in construction, and that resulted in most of them being very similar to one another, with few variations. The problem facing most owners today is that with improved oils, tyres and other components, the cars are now capable of higher speeds than they were in period. As a result, some modern techniques have been employed, as Knapton explains: "We have had Peter Weston do the suspension setup for us. He measured the geometry and calculated the right damper and shock absorber valving and spring rates, but that is the most modern thing that we have done to the B8."

LIMITED BRAKE COOLING

The brake system consists of discs on all four wheels which measure 262 mm in diameter and are 10 mm thick. The two-piston aluminium Girling callipers (model AR2) are standard items. However, the amount of cooling one can get to the brakes is limited as brake ducts are not allowed on the car.

At the front, an air intake either side of the main radiator grille directs air towards the brakes. "They have got internal venting in the body to direct air to the area of the brakes," explains Knapton.

The Chevron had its original aluminium fuel tank still fitted when Xtec Engineering took delivery of the car, but this was removed and replaced with a safety bag tank. Because the car had problems with fuel surging, a fuel collector was also fitted. In addition, there is a second tank in the front which the team is allowed to ▶

fit for longer distance races, and this can be activated by the driver by means of a switch on the dashboard.

GRACEFUL DESIGN

The Chevron B8's design is one of the most graceful from the 1960s, for the low and streamlined body was as beautifully sculptured as it was simple. This is in line with that old adage in racing that if it looks right, it usually is.

The cockpit is a generous size and offers good vision, both fore and aft. Along the car's flanks, and just behind the doors, are two further apertures. The upper, round-shaped inlet is for the rear brakes, while the NACA duct lower down lets cool air into the engine bay. At the rear of the car is an almost flat, vertical panel through which the exhaust protrudes. This has a removable cover which can be left in place, or the car can race without it, but as Knapton explains, "The theory is that it lessens the drag if it is left open, as the air gets trapped in the engine bay."

When asked if any B8s have ever been optimised in a wind tunnel, Cox replies, "I ▶



BELOW The left-hand gearshift is one of the car's quirks



BELOW The rev counter and speedometer take pride of place on the dashboard



ABOVE Arguably the most straightforward car in the Xtec Engineering fold, the Chevron has run like clockwork



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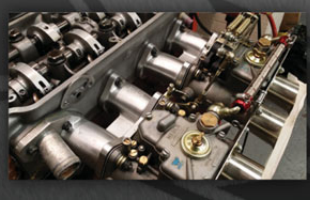
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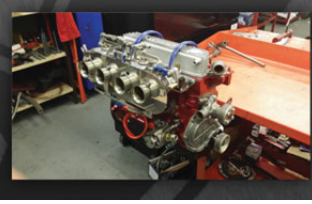
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have never known anyone put a B8 into a wind tunnel. It would be interesting to do it, though. The problem is where could you find any gains on it?"

SIMPLE INTERIOR

The cockpit interior is as simple as any other racecar, but at the same time, it is thoughtfully laid out. In the centre are two large dials, a rev counter and a speedometer. Asked why it had a speedometer, Knapton offers: "They had them originally, but in most of the B8s the speedometer didn't work anyway!"

Over to the left is a master cut-out switch, the starter switch (with red protector) and starter button. Alongside this are two toggle switches, one for the fuel pump and the other for the reserve tank when fitted up front. On the right of the steering is a clump of three dials showing water temperature, oil temperature and oil pressure, a windscreen washer switch and light switch.

Mounted on top of the dash is a Racelogic lap timer, while a video system is also fitted which is used for driver training more than anything else, according to Knapton.

Like so many other racecars of its day, the B8 was formed around a steel spaceframe reinforced with steel and aluminium panels. Cox explains, "It is just a tubular chassis consisting of square and tube box of varying size, depending on where it is. The B8s had steel panels that were brazed to the chassis in period, but today they are TIG welded. The reason they brazed them in period was because you didn't get the heat build-up that would distort the frame. Some people might say that is not as good, because it is not original, but if you throw it into a wall the last thing on a driver's mind is, 'Was that tigged or was that brazed?'"

The B8 has an aluminium floor and bulkhead, but the sills and all the panels in between are all steel. Wisdom should be exercised by owners of spaceframe cars from this era because, as Cox advises, "You have got to bear in mind that you need to look at that frame regularly. It is always a problem with historic cars, because someone can present a car that looks great on the surface, but actually the tubes have been rotting from the inside for years."

LEFT-HAND GEARSHIFT

The gearbox of the B8 sits behind the engine, which is in itself nothing unusual but the gearshift is in the



ABOVE A pair of Facet electronic fuel pumps sit alongside the fuel collector, which was installed because the Chevron had fuel surging problems



ABOVE Magnesium uprights were introduced in place of the originals from the Triumph Herald



ABOVE The B8's steel spaceframe is reinforced with steel and aluminium panels

middle of the car, on the driver's left. This means the shaft to the gearbox has to run up and at an angle across the car to link up on the bottom right (seen from the rear) of the gearbox. As a result, a lot of people converted the B8s to a right-hand gearshift.

The Hewland FT 200 gearbox runs on Motul Gear Competition 7590 oil. Knapton explains that the driveshafts are balanced and use GKN high-quality joints from Dave Mac Propshafts. "The one thing we did was, we had trouble with the gearbox crown wheel and pinion, so we had that made up by Tandler Precision, and we replaced it," he admits.

CURRENT RACING

Knapton outlines the car's first competitive race in his care: "We got it in 2015 and we did a Peter Auto CER (Classic Endurance Racing) race at Paul Ricard with it at the end of 2015. Tina went well. It was quite a competitive field and she qualified 42nd but finished 24th out of 38 starters in her first race." At this point the car was dark blue, but it was repainted its current light green over the winter of 2015.

The engine was rebuilt at the beginning of 2016, and Kok's second race was the CER event at Jarama in April where she qualified 29th and finished 19th overall. This was followed by the CER race at Spa in mid-May where she finished 26th, having qualified 41st on the grid.

At the end of June, Xtec Engineering took a batch of cars down to Pembrey where, on a brilliantly sunny day, they were all put through their paces in preparation for the Le Mans Classic in July. Needless to say, the Chevron performed faultlessly. Knapton adds with a smile, "Tina has been quite consistent in the car, and it has run like clockwork to be honest. In some ways, it's probably the most straightforward car that we have." At the Classic Le Mans Kok qualified the car 46th, but finished a creditable 18th overall (combined three races).

Then it was back to the track where she had first raced the Chevron a year earlier, Paul Ricard, where she once again put in a sterling performance. The fine run of finishes was not to last, however, as Knapton explains, "We have not had a DNF with the Chevron apart from the last race in 2016 at Imola, where, after qualifying 22nd, Tina retired following a crash. She was torpedoed by another driver in the right rear, when someone dived up the inside at quite high speed for a gap that was never there. They actually did quite a lot of damage, and it broke the chassis as well."

IMPROVED TECHNOLOGY

Some drivers are not that competitive, just wanting to go out there and drive their car, whereas others want to optimise everything. That, Cox points out, is where the technology comes in: "That is the difference with technology from 50 years ago, compared to now."

The team does use computer software for suspension analysis, but it is widely accepted that performance gains are found mainly in the rubber compounds in the tyres, better oils which give more engine power and better brake fluid that reduces overheating in the brakes. "Every little bit helps, but the tyres are the single biggest factor that give you your lap times," Cox opines.

The Chevron B8 is a fairly simple design and layout, and if you look at it from bumper-to-bumper, there is no sophisticated technology in it. Cox agrees: "From a mechanic's point of view, there was nothing complicated and it was easy to run. It was very basic technology, just done in a way that worked." HRT

• Thanks to Paul Knapton of Xtec Engineering and Ian Cox of WDK Motorsport for their assistance with this feature

THE ULTIMATE GROUP B CAR

Hal Ridge reveals how modern technology has transformed an RS200 for the 'Race to the Clouds'

For outrageously wild racing cars, think turbocharged Formula 1 machines of the 1980s. Or the stunning Group C endurance racers of the same era. Or, perhaps, the Group B rally challengers that were ultimately banned from the WRC stages in 1986 for being just too monstrous.

But, three decades on, what happens when you take the concept of one of those legendary Group B machines, renowned for being agricultural by nature and having more power than grip, and dose it with the most modern technology available? You create the "ultimate Group B car".

Those are the words of Liam Doran, owner of the LD Motorsports team that owns and runs arguably the most developed Group B car in history, a Ford RS200 adapted for hillclimbing.

Monstrous creations are not generally considered with cuddly affection, but this RS200, "affectionately" known as Roscoe, was acquired by Pat Doran in 2010. This is no 'ordinary' RS200 though, if such a thing exists. For starters, its monocoque tub chassis has been evolved into a



Stuart Santos-Wing

ABOVE The front aero package, seen here on the car at Shelsley Walsh, draws inspiration from the DTM

Phillip Thomas



ABOVE His flame-spitting assaults on the Pikes Peak Hillclimb prompted Pat Doran to suggest, "I wouldn't put my worst enemy behind the wheel of that car." His son ultimately solved the driveability issues

tubular spaceframe hybrid.

Multiple German hillclimb champion Dieter Knuttel won the series in 2000 with the car, but halfway through the following year it was shelved and split from its running gear. Having ended up collecting dust in Austria, the rolling chassis was bought by Doran Snr and re-mated with one of its original BDT-E 2.1-litre Evo engines. That was in 2010, and it's since climbed up the infamous Pikes Peak International Hill Climb, and been fitted with a 2.4-litre motor.

"From the start of its life this chassis was adapted into a spaceframe of sorts by [preparation expert] Geoff Page. From there Julian Godfrey evolved it into pretty much the chassis it is today; we've changed nothing in terms of geometry," explains Doran Jnr. "It's effectively full-spaceframe. The original aluminium honeycomb has been cut out and is now carbon fibre honeycomb, so the tub is actually stronger and lighter than the original, but looks identical."

While a 'normal' RS200 has bolt-on frames to the front and rear of its tub, the spaceframe of this machine links the whole chassis together, including the substantial roll-cage in the cabin. "It's a lot stiffer and a lot lighter than a standard RS200 chassis and the geometry is a lot different too," he says. "It uses original [double wishbone] suspension design, but it's basically all moved up in the car to lower the ride height [to 60 mm] and roll centre. They kept the original geometry measurements, they just moved it all up to lower the car down."

Only intended for use on asphalt, this car is now more circuit-racer than its off-road rally ancestors. "That's basically ▶

how it came. Since then we changed almost everything that's bolted onto it," continues Doran. "Technology has never improved geometry because geometry is a simple science. With modern technology geometry hasn't changed, it's just the bolt on bits that make this car faster."

The Doran family is synonymous with rallycross. Pat won events at European Championship level in a more traditional RS200, while Liam is a multiple European event winner and X Games Gold Medallist. Those feats were achieved in the headline Supercar machines that although famously brutal, are actually quite tame in comparison to this car.

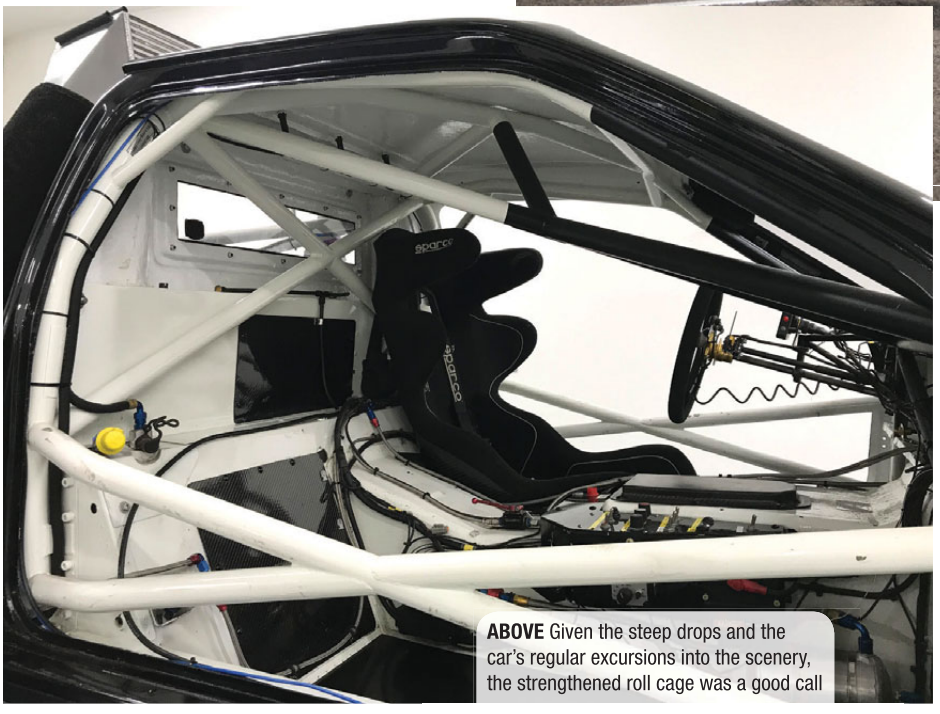
Doran Jnr's rallycross links, through his own driving and his team LD Motorsports, have played a significant

"It's geared to 150 mph but at that speed it's out of control"

role in the supply of components for this RS200. One such connection is through suspension manufacturer Reiger, that supplies the dampers. "They've never really been a key Tarmac player but from rallying they know what to do," he says. "These are the latest spec, three-way adjustable plus roll control [where the damper mechanically senses lateral loads, braking and acceleration and adjusts accordingly, featured in RT199]. They're the ultimate Reiger option."



Stuart Santos-Wing



ABOVE Given the steep drops and the car's regular excursions into the scenery, the strengthened roll cage was a good call

Much of the internals of the car have been adopted from Ford's Escort WRC, including adjustable blade-type anti-roll bars front and rear, and the hydraulically-operated steering rack, while the column has been custom made to suit the application. "A standard RS200 doesn't have power steering. When this came to us it actually had an electro-hydraulic pump on it, which always had resistance



ABOVE The brutal diffuser and F1-derived rear wing always capture attention

when moved left to right quickly, so we converted it to have a ZF hydraulic pump on the engine," says Doran. Custom uprights have been manufactured by CNC, from billet aluminium, as the original RS200 driveshafts have been replaced with Escort WRC items and the outer CVs were then too large for the previously used cast aluminium uprights. "RS200 front shafts are quite puny. Because the cars are light and the power wasn't mad, you didn't need more," he suggests. "This car's got so much grip, it just kept blowing outer CVs. So now it runs the big 108 mm inner CVs, then the largest shaft diameter and largest outer joint diameter we could fit in, which are from the Escort."

Attached to the uprights, within the 18" BBS magnesium wheels, are 380 mm Alcon brake discs and six-pot callipers all round, the same as those found on some of the latest GT racers. "Because it has 50:50 weight distribution you can run square braking like this. The rear brakes are massive for a car that only weighs this much," muses Doran. By comparison, an original RS200 left the Boreham factory with 300 mm discs.

The wheels that cover said brakes, wrapped with sticky soft-compound Avon 305 hillclimb slicks, are huge: 13" wide at the rear and 11.5" wide at the front.

The transmission has been significantly upgraded too. The RS200's original Xtrac five-speed transaxle system [referred to as such even though it's technically back-to-front for the conventional use of the term], has been replaced by a Quaife six-speed sequential gearbox and different internals in the differentials.

"It's advertised as doing 0-60 in 1.7 seconds and it really does because of the sheer size of the tyres and everything being so low. And it does that ▶

in first gear, so to get 60 mph you don't even have to change gear. It's geared to 150 mph but at that speed it's out of control. You could gear it to 200 mph if you wanted, but you wouldn't be getting out after you'd done that," says Liam Doran, only half joking.

Gear change is operated by a compressed air paddle shift system, using a ram and air cylinder, activated by a paddle on the steering wheel. That was fitted in time for Pat Doran's second attempt at Pikes Peak in 2013. Having failed to finish in 2012, he was 11th at the second attempt with a time of 10.14.187s, despite a "couple" of visits to the Colorado scenery in practice across the two years.





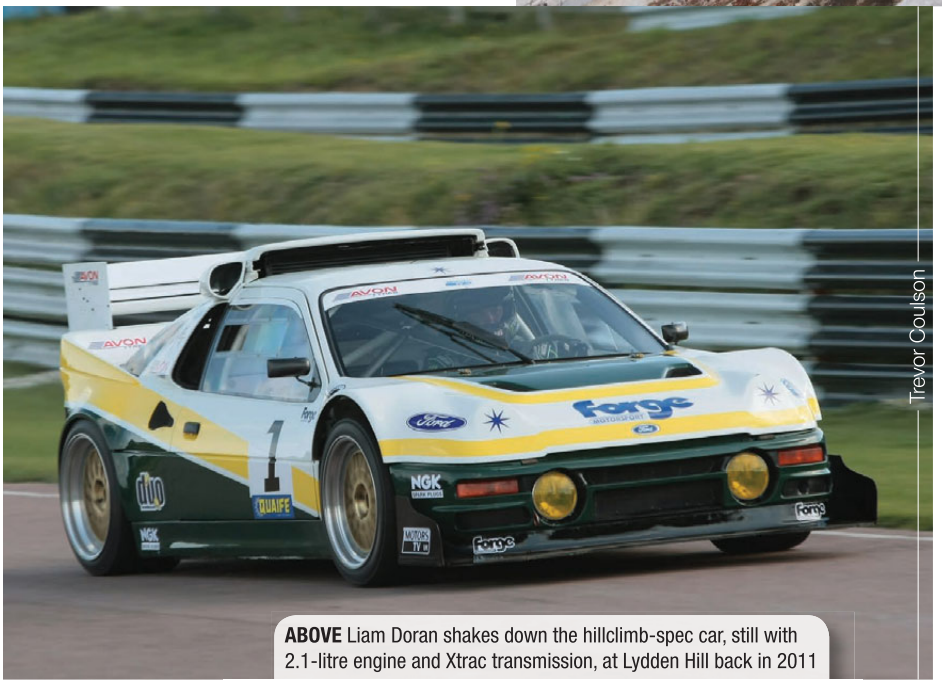
ABOVE & BELOW The monocoque chassis has been evolved into a tubular spaceframe hybrid that is stiffer and lighter than a standard RS200

AUTO UPSHIFT

"We used the Shiftec system with ECU and everything; it functions really well," says engineer Julian Godfrey. "We set the auto upshift so you don't have to shift up, it shifts when you get to peak RPM. Because the car's so quick and you go through the gears so quickly, it can make it quite nice to drive. The only disadvantage is that it sometimes upshifts even if you didn't want to pull another gear before the next corner, but then because it's paddle-activated, it's so easy to shift down."

Doran Snr admits that he found the car equally challenging to drive with the paddle shift system fitted for his second attempt at the famous hillclimb, but that the transmission has been the biggest change to the car: "It actually made it harder to drive when I did Pikes Peak, because with the sequential box and that amount of power that's trying to take you off the road, you had to drive it so calmly that you couldn't use the potential. When I did Pikes Peak I was always shifting early, because it just wouldn't hold onto the road. It [the paddle shift] never made it any easier for me, but what it did do was make the car more reliable and the system is just incredible.

"We developed the gearbox with Mike Quaife, because the Xtrac was getting on so much and just wasn't able to take that power. We've sent the gearbox back ▶



Trevor Coulson

ABOVE Liam Doran shakes down the hillclimb-spec car, still with 2.1-litre engine and Xtrac transmission, at Lydden Hill back in 2011

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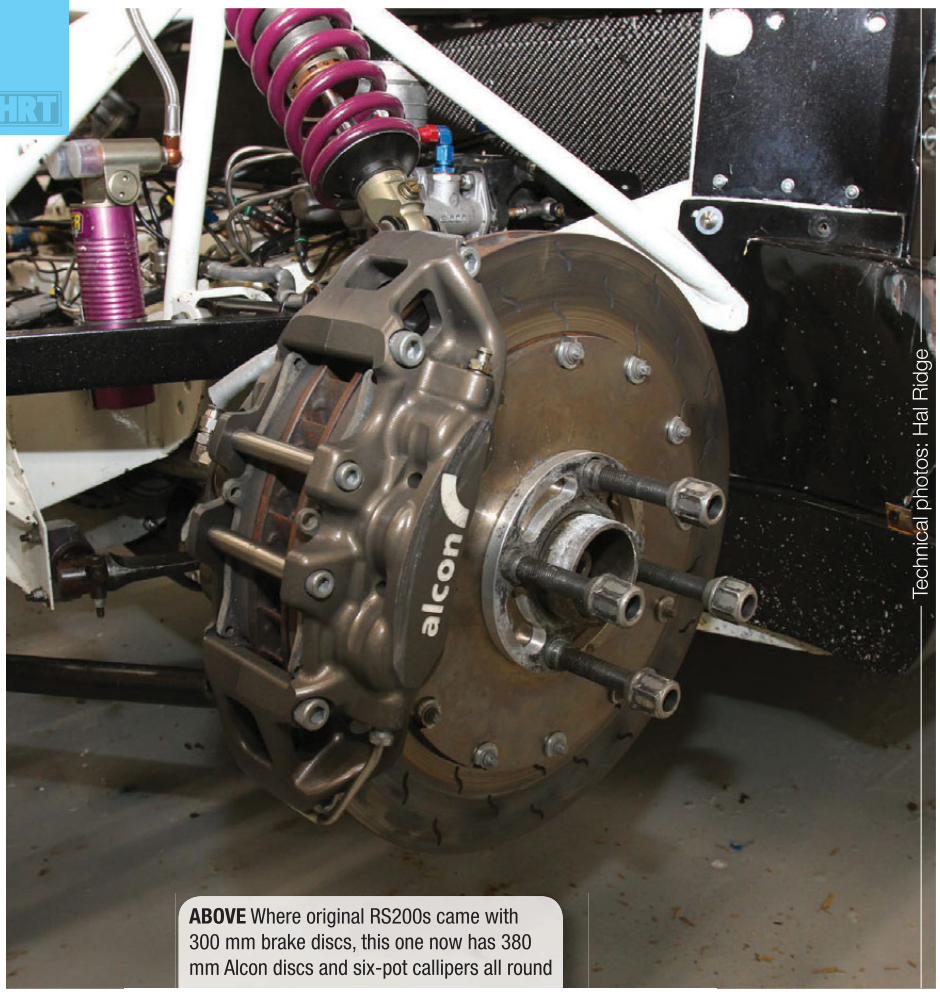
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Technical photos: Hal Ridge

ABOVE Where original RS200s came with 300 mm brake discs, this one now has 380 mm Alcon discs and six-pot callipers all round

several times and it's not even touched the dogs, let alone the gears. That's been the big change to the car."

The four-time British Rallycross Champion says the car has improved significantly since his own hillclimbing exploits. "The famous thing that always came out of me doing Pikes was that the car was trying to kill me, and it was. I wouldn't put my worst enemy behind the wheel of that car. In the end it was my son who sussed out why it was undriveable. The problems were mainly with the differentials, which meant when I hit the throttle the car just wanted to drive off the road. 'The hill' was everything from petrifying to exhilarating, especially in this car, but I don't care who you are, Sébastien Loeb or anyone. Sébastien told me after he'd done his [record-breaking 8m 13.878s run with Peugeot Sport's bespoke 208 T16 in 2013] it was the last time he'd ever do it, that's how dangerous it is. This car has improved a lot now [though]."

As part of differential improvements, an Escort WRC has also donated its Xtrac front and rear diffs for this creation, located in original RS200 housings. Originally, RS200s ran viscous torque differentials, while the Escort is a plate and ramp setup to allow for not only increased performance to handle the extreme power, but also adjustability. The centre diff remains of viscous design, but converting that to either plate and ramp or even fully active is high on the LDM list of jobs for the next set of evolutions.

"The viscous centre diff is probably the biggest downfall of the car at the moment. You can't lock and unlock it freely because it's run at a set hydraulic pressure and that's what you've got all the time," says Liam Doran. A billet aluminium rear diff plate, bellhousing, transfer casing and gearbox mounts have replaced the original RS200 cast magnesium items no longer strong enough to deal with the increased performance.

An Alcon triple-plate carbon clutch with internal slave cylinder engages and disengages drive from the engine. It is a similar design to what is run in current rallycross Supercars but "as heavily sprung as Alcon could make it".

If the transmission is a significant evolution in the car, the engine is arguably just as much of a development on what was originally housed in the rear of Ford's Group B machine. From the Boreham factory RS200s were fitted with 1.8-litre, four-cylinder, 16-valve BDT Cosworth units, producing around 400 horsepower. The RS200 2.1-litre Evo engine, developed by Brian Hart, arrived after the machines were banned from rallying, but were used in ▶



ABOVE New ducting has improved the aerodynamics and airflow through the radiator



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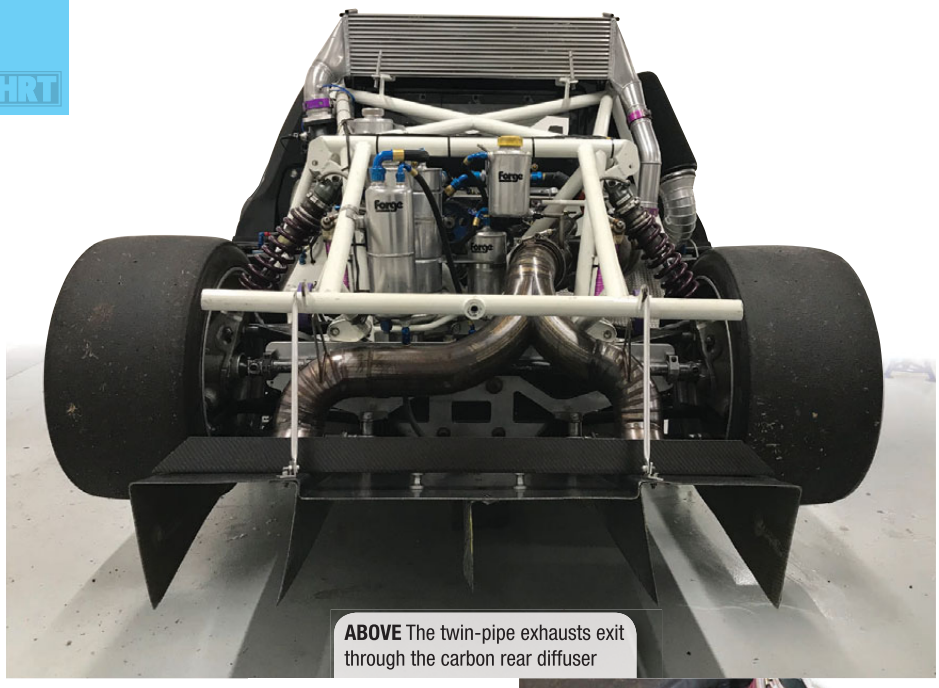
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ABOVE The twin-pipe exhausts exit through the carbon rear diffuser

rallycross. That is what this RS200 used to win hillclimbs in Germany and what was fitted when Pat Doran contested Pikes Peak, but it's now an even more developed 2.4-litre unit that's nestled into the rear of the spaceframe.

"Pat used the 2.4 at the Festival of Speed for the first time in 2016," explains engine-builder Godfrey. "It's the same bore size (90 mm) as the 2.1 just with a longer stroke crank, to give it more torque out of the corners and a bit more response to make it easier to drive and run less boost."

1000 HORSEPOWER

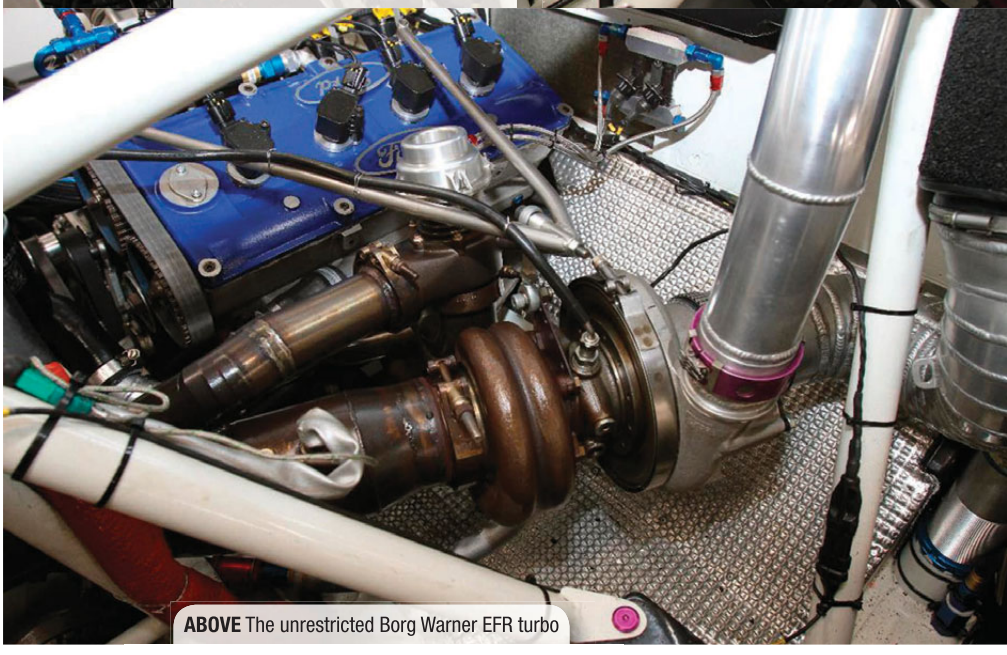
The turbo is an unrestricted Borg Warner EFR item, again similar to those fitted to the latest two-litre rallycross Supercar motors that leave Godfrey's Sussex workshop, which Doran's team also uses. "Everyone said you needed 1000 horsepower for Pikes Peak, so Garratt supplied a turbo that could produce that and work well at high altitude for 2012," says Godfrey. "But it made it pretty undriveable. Nothing really happened until 7000 rpm, especially with the Xtrac 'box. Changing to the smaller turbo and sequential gearbox has made it much better."

Now, the heart of this RS200 'only' produces around 940 horsepower, with approximately 700 ft/lbs torque. The rev limiter is set at 9,300 rpm, the point at which peak power is produced. "When we got the car it was all trips and fuses, with original Escort WRC T6 engine management," adds Liam Doran. "Electronically, we've changed everything. It's still on Pectel Cosworth but it's been updated to an SQ6 ECU and the very latest software. It's all [MoTeC] PDM controllable. Everything is the latest 2017 spec – injectors, coils, spark plugs – because that's really what gets the efficiency and reliability. That's what technology brings to something like this."

The exhaust manifold is fitted with a DSPS Engineering wastegate found on WRC machinery and rallycross Supercars to control boost. The inlet manifold is a Swedish-made Tibuc quad-throttle inlet system in a move away from the original ▶



ABOVE Improving the differentials has been crucial in taming the car's handling



ABOVE The unrestricted Borg Warner EFR turbo

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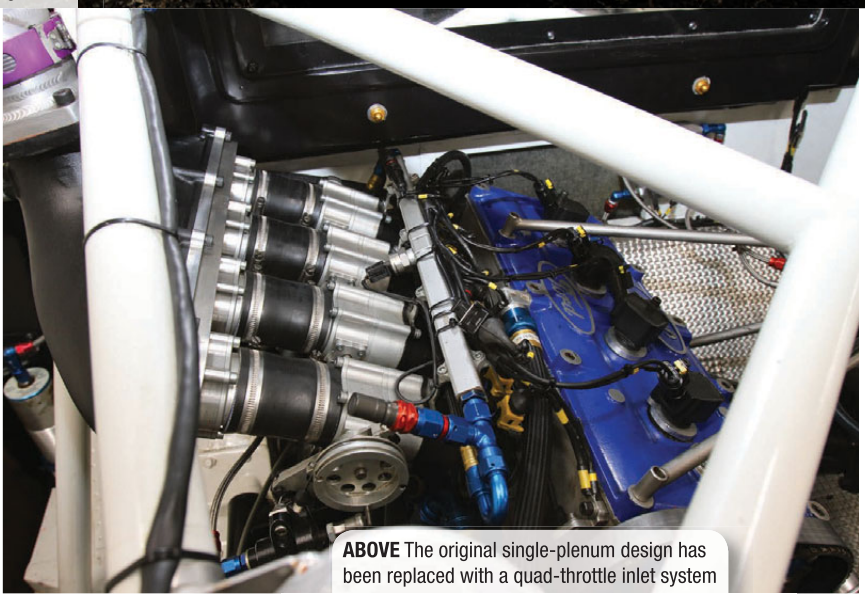


ABOVE Changing to a smaller turbo and sequential gearbox has extracted the most from the 2.4-litre engine

single-plenum design to produce more torque and response.

"Tibuc actually had to make a larger manifold for this car because it needs so much air," says Liam. "They're 65 mm bodies, the rallycross Supercar is normally 52 mm, and they're oval to suit the ports."

The front-mounted radiator, like the roof-mounted intercooler and the majority of the aluminium tanks and cooling pipes, has been produced by Forge, using HM Marston cores, the equivalent to those used in Formula 1 and the aerospace industry. New ducting has been implemented at the front to improve aerodynamics and airflow through the radiator.



ABOVE The original single-plenum design has been replaced with a quad-throttle inlet system

MODERN TAKE OF A GROUP B CAR

"We also run a BMW Mini PWM-controllable Pierburg water pump because they're the latest and best. All the pipe work is the best from BMRS [Brown and Miller Racing Solutions]. Everything is the ultimate of current spec parts, so as far as I'm concerned, for sure in the RS200 world – maybe even in the whole Group B world – it's the most modern, modified take of a Group B car," grins Doran. "It's got the original design of the car but it's been taken to the ultimate."

The total weight is currently 1040 kg wet (full of fluid) as the car is clad with largely Kevlar bodywork due to Doran Snr's altercations with the Colorado scenery when competing on PPIH. When that is soon replaced with carbon fibre items [rear clam and front bonnet which is of different design to a conventional RS200] the weight will be around 990 kg. "Bar a few horsepower, that's almost 1:1 power to kilo, which makes it really insane," says Doran Jnr, with an even bigger grin.

The twin-pipe unsilenced exhausts exit through the carbon rear diffuser, while an F1-derived wing sits on top of the clam at the rear. At the front of the flat floor, a front splitter inspired by a DTM racer also increases downforce.

"Apart from the bodywork, a couple of things we're going to try and change are to convert it to a fresh air anti-lag system," continues Doran Jnr. "It still runs a throttle bypass with a throttle-jacker for the paddle shift so it can blip on down-changes. But, that's only the air going through the engine that

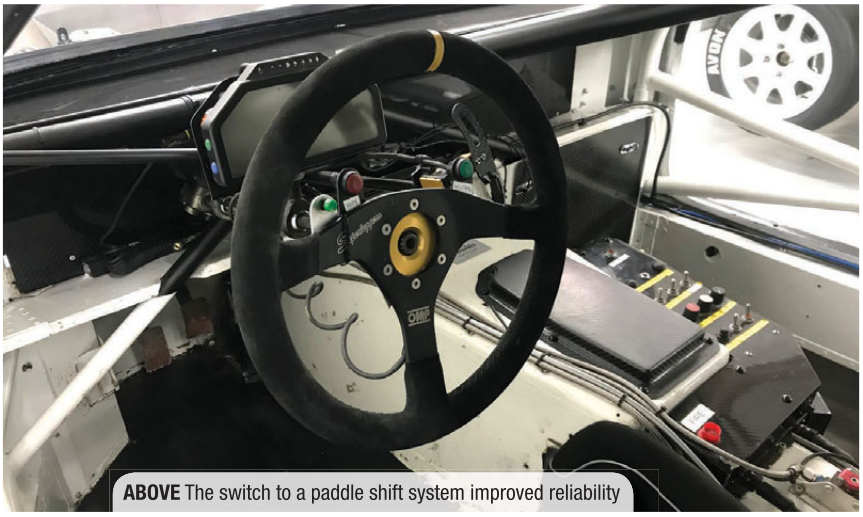
> **“I don’t think there is anything else you could do to an RS200 to make it faster, apart from put a driver with less brains in the seat”**

keeps it going, by going to current spec fresh-air, you’re bypassing air around the cylinders to keep the turbo spinning,” he says.

“We’re going to go for an electronic servo motor on the bodies too so it effectively becomes fly-by-wire so then we can really play with traction control and response. We can get so much data feedback from damper pots and wheel speed sensors. At the moment it’s a bit laggy, then when it comes on boost it’s really insane. The only other thing is to use a Bosch Motorsport ABS system like they run on the GT cars. In hillclimbing you lose a lot of time in the first couple of corners because of the brake temps, so ABS is a massive performance gain.”

Through his career as a rallycross Supercar driver, which began at the deep end by racing a rallycross RS200 in 2008, Doran Jnr has become widely known for his hugely committed driving style and the slogan of ‘fear nothing, risk everything’. But, even the most fearless and experienced of drivers has reservations about pushing to the absolute limit in this most extreme of Group B evolutions.

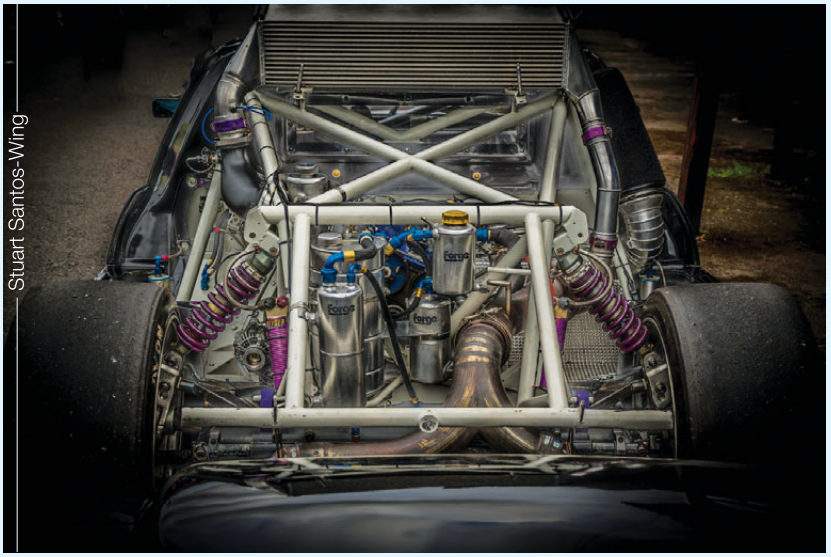
“Once we get round to doing those little things, I genuinely believe it will be the ultimate Group B car,” he says. “I don’t think there will be anything else you could do to an RS200 to make it faster, apart from put a driver with less brains in the seat. It really is phenomenal. It has so much grip that it doesn’t go sideways, it doesn’t spin the wheels, it just goes forward at a really, really fast rate. You get into it hoping it serves you well and praying for the best ending. It’s not fun, it’s a phenomenal experience.” HRT



ABOVE The switch to a paddle shift system improved reliability

RS200 Pikes Peak Spec

Brakes	Alcon
Suspension	Reiger
Transmission	Quaife
ECU	Pectel SQ6
Paddleshift	Shiftec
PDM	MoTeC
Dash	Omega D2
Fuel tank	ATL
Intercooler	Forge with HM Marston cores
Radiator	Forge with HM Marston cores
Hydraulic steering pump	ZF
Wheels	BBS
Tyres	Avon
Turbo	Borg Warner
Water pump	Pierburg
Pipework	BMRS
Steering wheel	OMP
Inlet manifold	Tibuc
Air jacks	AP Racing
Seat	Sparco
Harness	Sparco
Steering rack	Escort WRC
Driveshafts	Escort WRC
Anti-roll bar	Escort WRC



Stuart Santos-Wing

RESTORING A MASTERPIECE

A crashed racecar is a sorry sight. **Alan Stoddart** finds out what it takes to restore these crumpled heroes to life





ABOVE & BELOW This Bizzarrini is just one example of G&A's amazing restorative powers

The most dramatic part of the Goodwood Revival or the Silverstone Classic is watching millions of pounds worth of some of the most beautiful cars ever made furiously out-braking one another, seeing drivers hold their nerve and attempting daring overtakes on the outside of tightening turns and shimmying two abreast through chicanes. However, sometimes when the driving is particularly enthusiastic, the line between a breathtaking pass and a reckless lunge is crossed, and before you know it, a priceless racer is sitting sadly crumpled at the side of the track.

As a spectator, it is easy to watch the car get taken away and forget about it as you become immersed in the next race. However, there is a huge amount of work in bringing the metalwork back to a pristine condition, especially if this involves preserving as much original metal as possible. This is specialised work and relies as much on experience and a feel for the job as any formal practice or method. One place that still possesses these skills is G&A Fabrications, where the bespoke nature of the work is extolled throughout the workshop.

"A lot of our tools are handmade," explains the company's founder, Lawrence Kett, opening a draw of subtly different metal tools. "These are called flippers, we make them from old leaf springs, or old files...

you can't put a value on a lot of these tools, a lot of these are all handmade to do specific jobs."

This specialism is necessary given the range of the work that comes in and overall importance of keeping everything original. No two jobs are the same, which means that Kett's team need to be as much researchers as craftsmen. Existing material is used and re-shaped as much as possible, but sometimes the extent of the damage means that new metal needs to be brought in. To ensure it is as close a match as possible a sample of the original is sent away to be analysed in order to ascertain its chemical composition.



ABOVE One of many draws of handmade tools that G&A uses to shape bodywork



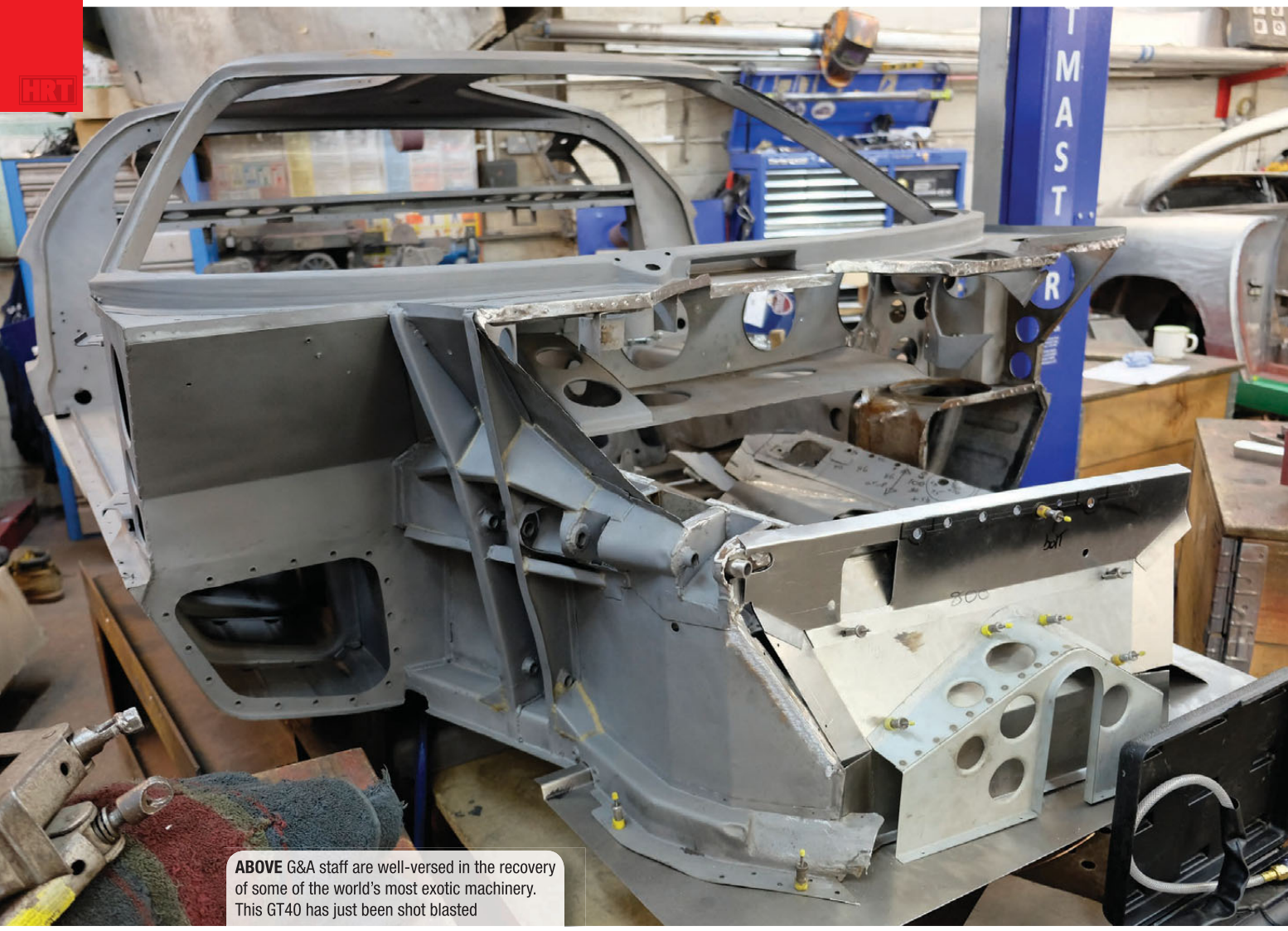
ABOVE The wheeling machine, mastery of which is crucial to a racer's smooth curves

With this information G&A is able to approach metal suppliers and ask for a metal that most closely mirrors the original, before getting the go-ahead from the owner. "They know it will be created with the original techniques, and is as close as we can possibly get to the original metal without going back to the sixties," says Grace Roaf, one of the company's fabricators. "Then you've actually got to go and make the metal do the shape you want."

Although almost everything is done as it was when the cars originally rolled out of the factory, Kett is not against modernisation. "You have to move with the times because technology does help and it can actually work in your favour," he says. "Although we're living in the past, technology does help in a lot of ways." Laser cutting the panels out of sheet metal is one of the newer technologies used by G&A. Before fifty-year-old drills and homemade hammers are let loose on the material, the laser cutting allows clean and accurate shapes to be made, so they provide a good basis for the more hands-on parts of the fabrication.

A GENTLE BEATING

"It can be so frustrating," Roaf explains. "You'll want it to go straight and it'll go to the side, so you'll think, 'Well how do I get that back?' so you crimp a bit here, and then stretch a bit there and ▶



ABOVE G&A staff are well-versed in the recovery of some of the world's most exotic machinery. This GT40 has just been shot blasted

it's mind games. You play mind games with yourself about how to make metal, this indestructible metal that builds bridges and builds houses, do what you want it to do."

Getting the material to form the shapes is a far gentler process than the term 'panel beating' suggests. "Everyone thinks you need to be so strong and beat the hell out of it, but we hardly use the big hammers. We use the flippers and literally pat them down so softly," Roaf continues. "Hitting the right place very gently is much better than hitting it very hard in the wrong place."

> **"Hitting the right place very gently is much better than hitting it very hard in the wrong place"**

Knowing what shape to aim for is another problem facing the metalworkers at G&A. In another nod to modern technology, lasers are used to align everything and ensure that all the measurements are correct. However, while the chassis work is very meticulous and has to be spot on given geometries and set ups will be taken against it, the handmade nature of the cars G&A typically works on means that the differences in measurements of panels, even on opposite sides of the same car, can be "astounding". This means that the fabricators can do a job to the exact measurements and then stand back and still it won't appear to be correct. In these cases Roaf explains that ultimately, the most important thing is getting it to look right to the eye. No one is taking measurements of the car when they see it, but "It's got to look right when it goes past on a racetrack. It's *got* to look right."

One of the other problems facing G&A is a shortage of new recruits. The service provided by the craftsmen is often unfairly overlooked, while the extensive reliance on traditional techniques means that many would-be panel beaters come out of college without any of the skills necessary for a life fixing damaged GT40s, Cobras and D-Types. G&A Fabrications and others like it offer apprenticeships, but uptake is still surprisingly small. Given this shortage, and G&A's reliance on skilled workers, Kett implores anyone interested in working for the company to get in touch.

So, instead of forgetting about the car that ends up crumpled in the tyre wall, or only noticing the amazing V12 of a finely resurrected classic howling past, take a moment to appreciate the incredible skill of the fabricators that means we can continue to enjoy the beguiling shapes of all those iconic racers. HRT

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MAKING THE MOULD

There are few spares available for 100-year-old Rolls-Royces, but as **Alan Stoddart** finds out, the situation can still be salvaged

As many people involved in historic racing know, one of the perennial problems is finding parts. The older and rarer the car is, the more pronounced this problem becomes, until, as is the case for James Black who is restoring one of three works racing cars built by Rolls-Royce for the 1913 Alpine Trials in Austria, the only option is making a component from scratch.

The car was found in a dismantled state in a barn in Belgium several years ago and is slowly being brought back to life. There were however several components that required special attention during the rebuild, including the car's gear quadrant bracket, which is specific to the three Alpine Trials Rolls-Royces.

Fortunately for Westfield Patterns, which took on the job of making the pattern to cast the quadrant bracket from, there was at least an original drawing from Rolls-Royce's archives to work from. Despite this bit of good luck, it didn't provide all the necessary information.

"The drawing is what you'd call a blueprint with a dark background and white writing," explains patternmaker Paul Cox. "All the dimensions are completely up the creek because they originally just used whatever seemed right, so you'd get some really odd numbers, 1.887th of an inch and things like that.

"Because of this I do my own drawing and convert everything into millimetres for a start... The drawing original was also missing some information. At the time the patternmaker would have gone to the draftsman who would have told him, 'Just do it like this'. We obviously can't do that so we use patternmaker's license."

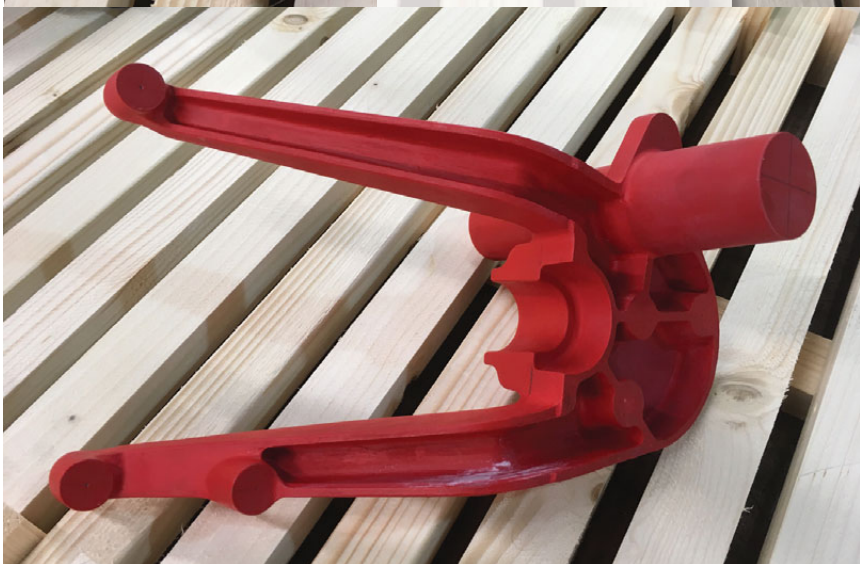
This freedom often involves making angles, which unfortunately for patternmakers often means trigonometry. "At school you have to do trigonometry with your sin and co-sin and all that, then you'd start crying," he laughs. Fortunately for Cox that has changed thanks to the apps available on mobile phones. "In the early days I'd get my old school log book out and scratch my head, but mobile phones make it so much easier. Nobody likes doing trigonometry do they?"

In the bracket, the most crucial thing is the bosses, which need to be in the right place for the final casted component to fit correctly, but the parts linking them rely more on the patternmaker which is where the maths come in. "It's using things you pick up over the years, so using ribs at the



ABOVE Westfield's patterns are made to impressively tight tolerances





ABOVE & BELOW The finished pattern – an exact handmade version of the bracket

> **“The dimensions are completely up the creek because they originally just used whatever seemed right”**

side or a radius at the bottom and things like that,” he says. In addition to this, Cox also needs to ensure the piece is strong enough in all the right places.

“It’s alright piecing a few little bits and pieces together, but it has got to go to a foundry and they manhandle the bits,” he adds. “Because it’s such a weak little thing we also have to make an odd side, which sits it at the right attitude to be moulded.”

In addition to this, the 1913 drawing didn’t include any taper, which is something else that has to be taken into account for the part to mould correctly. So this also had to be added to the plans as well as being taken into consideration when carving the pattern.

This part of the process is at least made easier by modern materials. Originally all of the patterns would have been carved out of wood, which can be problematic because of its grain, knots and other inherent inconsistencies. When the Rolls-Royce was built, the patternmaker would have had to select a bit of wood with which to make the pattern, and make decisions about the best way to approach the material in order to make it easier to shape.

Cox still uses wood and other traditional materials for some parts, but he also uses newer things like casting resin, and something called tooling board, which is “just like a synthetic wood”. This means it can be carved using traditional techniques, but doesn’t have all the drawbacks that wood itself has.

Considering everything is completely hand-crafted, tolerances are impressively tight. “For a raw pattern like this I work to a tolerance of about a millimetre,” notes Cox. “Of course, when they are finished that will go down to whatever a modern machine will do, but we try to work with the raw cast to less than a millimetre.”

This last stage of manufacture, the final machining of the parts, is always incorporated by Westfield at the design stage. When looking at the drawings, the patternmakers add on a machining allowance of two or three millimetres, which means the final cast component can be put in the milling machine or be turned to properly finish it, or to be precisely drilled out using jig drills, for example.

Westfield Patterns, as the name suggests, only worked on the pattern for the piece. After Cox studied the drawings, ensured the part would work flawlessly in the high-tensile steel that the customer planned to make it in, and meticulously carved the pattern, the equipment was sent to a foundry.

At the foundry, the pattern is used to make a sand mould of the part. The foundry uses a steel box full of special sand, to make an exact impression of the part. They then turn that over and make another side with another box, but this time with an opening through which the molten metal can be poured. When the pattern is removed and the two halves of the mould are placed together, a hollow the exact shape of the final component is left.

Although the moulds are broken down after each casting, the same pattern can be used over and over again in order to series produce parts. In the case of the Rolls-Royce’s gear quadrant, several identical parts will be cast so there are a few spares available just in case one is needed in the future.

Despite the obvious complexity of what Cox does, he remains prosaic about the patterns he makes at Westfield.

“I don’t think a lot of people know the actual process to get castings,” explains Cox. “They just see a lump of metal and don’t see the complex process that is involved in getting to that stage. We’ve done cylinder heads and all sorts, and they are very complicated with all the cores inside them.”

“But,” he concludes, “it’s just something that we do.” HRT

CONTROLLING BEETLE MANIA

The PPJ Racing Beetle propelled to TV fame by Jenson Button has been developed further. **Hal Ridge** finds out whether the beast has been tamed

Sadly for PPJ Racing, not long after Historic Racing Technology featured its monstrous rallycross Volkswagen Beetle in early 2016, it suffered engine problems in an event at Lydden Hill, gear selection problems being compounded by a broken camshaft.

Once again, the machine retuned to its Norfolk home with work to be done.

But, every cloud has a silver lining. Father and son pairing Paul and James Harrold had been brainstorming further upgrades to the car for some time. In the weeks and months that followed they devised a plan to improve their Retro machine further still, to make it more usable without changing its soul.

The PPJ Beetle was originally built for use by Paul's late brother Peter in the early 1980s. It underwent a number of transformations in its first career, including being switched between two and four-wheel drive configurations. With the car latterly restored for James to drive in Peter's memory, the HRT8 cover story charted the Beetle's history, and documented recent developments, including a more modern Garrett TO4S turbocharger replacing the previously used T4 version, in an attempt to make the car more driveable.

It worked, to an extent, bringing the boost threshold to 5,500 rpm, down from 7,000 previously, while trying to harness the horsepower produced by the boxer-based engine, using an



ABOVE The imprecise nature of the gear selection is one of the issues that has been addressed



ABOVE The engine problems encountered at Lydden Hill necessitated a spell on the sidelines – and a rethink

American Volkswagen block and water-cooler, eight-valve, twin-cam Subaru cylinder heads. The output figure was, and remains, 600 bhp, all delivered to the ground via the Revolution rear wheels, wrapped in sticky Avon slick rallycross tyres.

But, despite the upgraded turbo increasing the ability to set staggering lap times, as good as the majority of modern two-wheel drive racers in the British Rallycross arena, the car was still difficult to handle, to say the least.

Since its Lydden Hill event retirement in 2016, further significant developments have meant moving away from mechanical fuel injection and distributor to a much more modern engine management system, by way of a MoTeC ECU. "We've ditched the old Kugelfischer pump for the fuel injection, which was what they used on the Zakspeed engines, with boost enrichment and everything else, and the distributor, which was like a modified VW Polo distributor, and gone for a MoTeC ECU," explains Paul Harrold.

> **"They brainstormed a plan to make it more usable without changing its soul"**

"We needed a bit more reliability and a bit more control in terms of looking after the engine. With the old setup the spark was retarded mechanically by the distributor, which was always a bit iffy, and you were relying on a mechanical pump that you didn't have much control over. By running an ECU you can control all that more closely and hopefully that can give us more reliability and make it more driveable."

MAKING CHANGES

As 2009 Formula 1 World Champion Jenson Button discovered when he drove the car for a BBC F1 feature in 2015, this home-grown racer was previously renowned for its toggle-switch like power delivery, but the recent work carried out has been to largely improve that situation.

"Before, everything all came in in one big lump and if you weren't ready for it, it was difficult to drive," concedes Paul. "We've gone for an electronic boost control, the proper Subaru coil packs, because we run Subaru heads. The turbocharger and exhaust are the same – it's really just the ECU and electronic injectors rather than mechanical. Matt and Olly Clark at Roger Clark Motorsport have been very helpful and supplied the injectors, fuel rail, fuel pressure regulator, knock sensors and other bits and pieces (similar to those used on the famous Gobstopper Subaru time attack machine driven by Olly Clark).

"We talked about going to eight injectors rather than four. But we're told the modern injectors are so tractable and generally better than the old type, you can get what you want out of four so we've still only got one per cylinder."

Other modern quirks facilitated by using an ECU include a "reliable rev ▶



ABOVE The switch to a MoTeC ECU is a pivotal part of the update package

been done in-house at Paul's workshop. He has spent countless hours over the last 12 months working on the car that has become a member of the family, including building the engine, installation and packaging work. Some of the machining and fabrication has been outsourced. "Some stuff we have to contract out, but the majority we do ourselves. Dave Rowe at EPS supplied the ECU and loom, he will do the mapping at Roger Clark Motorsport, and Richie Bensley at Competition Fabrications in Attleborough, has been brilliant."

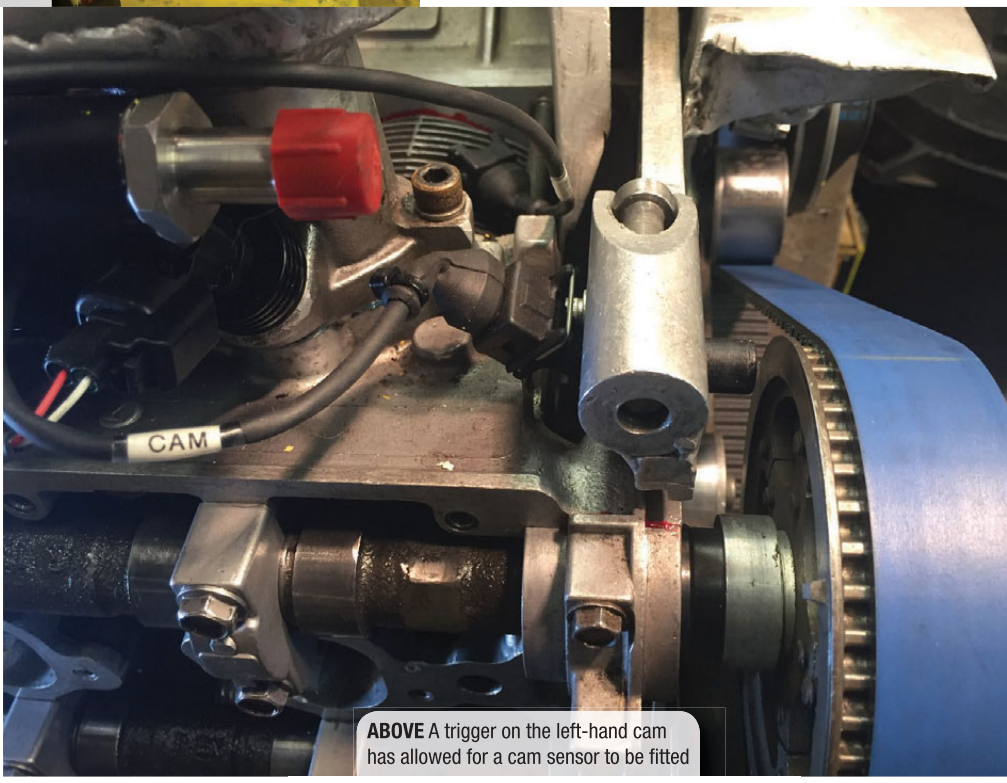
Another of the significant problems with this Beetle previously, highlighted by both Button in his BBC feature and by regular driver James Harrold, a former Stock Hatch rallycross champion in the category's heyday, was the imprecise nature of gear selection. The Hewland DG300 gearbox sits upturned in the rear of the car, and previously used a Porsche linkage.

"The Porsche gear change sort of worked but it wasn't particularly brilliant, so we've got a shifter now from the States, from Fortin Racing. These are designed for rear-engined cars that run a DG300, mainly on Beetles I think. We've installed that and it's so much better. It should make a big difference,

limiter", anti-lag and flat shift. The trigger wheel for the crankshaft sensor has been mounted onto the existing flywheel. Paul and James had originally hoped to mount onto the engine's front pulley, but there was no space available due to belts for the water pump, oil pump and power steering all being run from that location. A trigger on the left-hand cam has allowed for a cam sensor to be fitted.

With engine components becoming increasingly difficult to get hold of, Omega has produced new pistons, replacing the previously used BDT Cosworth items that "they just don't make any more," says Paul. "We're running more compression now, the ratio has gone up because we've got a bit more control, which should again make it more driveable too," he says, without giving away the figures.

Much of the work done to the car has



ABOVE A trigger on the left-hand cam has allowed for a cam sensor to be fitted

the driver will have no excuses now," jokes Paul. "We've changed the steering ratio too, not the rack, just the linkage between the rack and the steering arms, to sharpen the steering up."

While the extensive changes to the car are clearly two-fold, to increase its reliability and driveability, at its heart, it isn't far removed from how it was: a 600 horsepower monster.

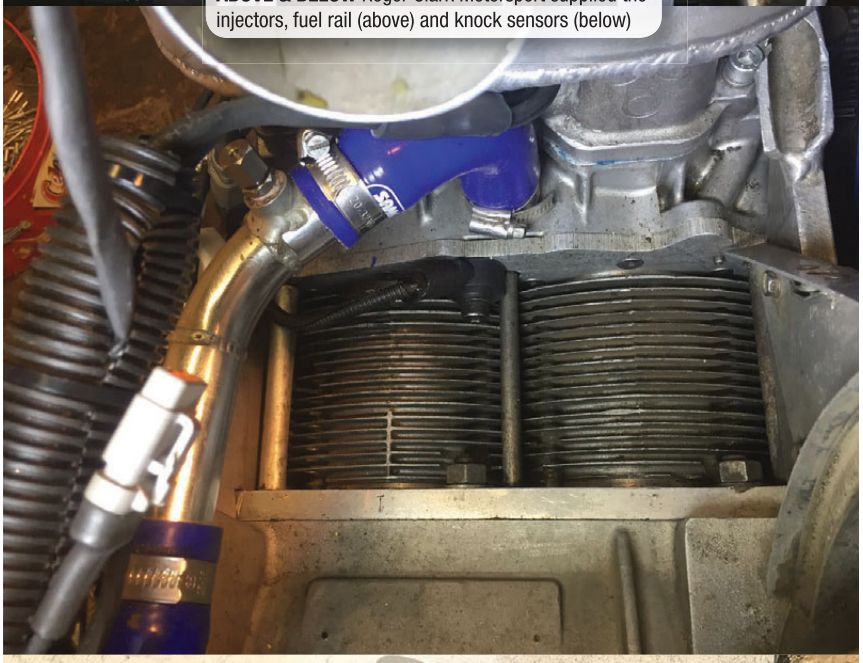
TRACTABLE POWER

"We're not going to get a lot more power out of it, but at the end of the day we don't need more power. The problem was always being able to use what we've got. Trying to run that sort of power through two wheels is always going to be difficult, especially turbocharged because it's not as controllable as normally aspirated horsepower. The car doesn't weigh anything apart from the engine [950 kg total with a 60:40 weight distribution] and that's all sticking out behind the back wheels. Porsche obviously worked around those problems, but we don't have the resources that they've got," explains Paul. "I'm not an engineer; I'm self-taught so sometimes things don't go according to the plan. We're keen to get it done properly and it's just perseverance really that's seen us through so far. We get there in the end; we want to go rallycrossing with it and we want to be able to do it without having to rebuild it every time we come back from a meeting."

Having an excess of power is largely pointless unless it can actually be used, but ahead of the 2018 rallycross season, the Harrolds' competitors would be right to feel concerned. The Beetle was competitive in its previous guise but with the developments undertaken over the last 12 months, it should be an even faster proposition.

"I never did, but if you worked out how much of the lap we spent on full power, the percentage would be quite small," notes Paul. "What we're trying to do is get that percentage up and we'll improve the lap times. Until you drive it you don't know, but it can't be any worse than it was. It should be an awful lot better." HRT





ABOVE & BELOW Roger Clark Motorsport supplied the injectors, fuel rail (above) and knock sensors (below)



ABOVE The old pump used by Zakspeed is, like the distributor, headed for the bin

Lancia Delta Integrale

Peter Collins
Published by Veloce Publishing
ISBN 978-1-787110-76-2
160 pages
£35.00/$50.00



LAST issue we reviewed Peter Collins' reprinted book on the Lancia 037, Veloce Publishing now following that up with a reprint of his book on the Delta Integrale that was first published in 2003.

The first part of the book concentrates on the birth of the Delta, which includes the Beta Montecarlo Turbo, the 037, the Delta S4 and the Delta HF4WD, the latter having a chapter all to itself. The book then opens out on the Integrale with a chapter titled Integrale - addressing the HF4WD's problem areas, and this is where things start to get interesting for the technically minded.

The book then goes into the rallying history of the Integrale, which won a further four more World Championships following on from the one that Lancia achieved with the HF4WD in 1987. What brings this section of the book to life, though, are the various interviews with those involved in the Lancia rally team at the time.

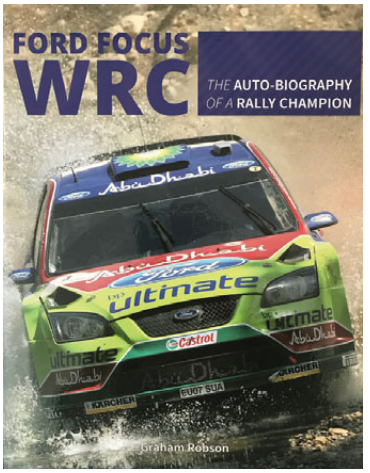
Having just won its fifth World Championship in a row in 1991, there then came the bombshell press release from Turin announcing that Lancia was suspending its competition activities. The reason was that Paolo Cantarella, the boss of Fiat Auto, was fearful that one bad crash involving the public would wipe out all the good publicity that the marque had accrued. He was also questioning the expense of it all, with the budget being accordingly cut. The result of this policy was that the engines and spare parts were given to the Jolly Club Martini team that comprised top people from the Lancia rally programme. However, 1992 was the car's swansong, enabling Lancia to claim the World Rally Championship for Manufacturers but not the Drivers which went to Carlos Sainz in his Toyota.

A further chapter in the book examines prototypes and concept cars based on the Delta Integrale with the final short chapter on owning and driving one, the heading being 'happiness or heartbreak?' which perhaps sums it up.

This is a well-researched and written book with evocative period colour pictures and as with the Lancia 037 book, will be a welcome addition to any Lancia lovers' library. HRT

Ford Focus WRC

The Auto-Biography of a Rally Champion
Graham Robson
Published by Veloce Publishing
ISBN 978-1-787110-20-5
192 pages
£35.00/$60.00



THIS book deals with a subject that is almost too modern for this magazine, but deserves to be reviewed as it is just so good.

Graham Robson, who has countless books to his name, has done his usual thorough job. As he acknowledges in his Introduction, the Focus World Rally car only covers a 12-year period, but such was its success and achievements, that it deserves to be recognised.

He starts the story off with a chapter on the four-wheel drive Fords before the Focus, including the rallycross four-wheel drive Capri, the mid-engined RS200 in the mid-1980s, the Sierra Cosworth 4x4 in the early '90s and the Escort WRC in the mid to late '90s.

The Focus WRC story itself begins with a chapter on the design team behind the original car in 1998. It also contains an interesting timeline showing its development from January to December 1998 that then leads into its first year of being campaigned in 1999.

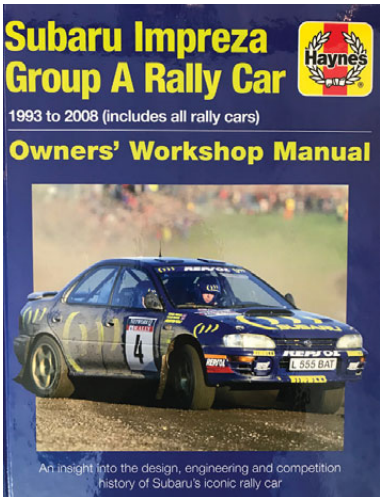
The book is full of interesting asides such as the Cosworth versus Mountune scenario, the latter losing out when Ford bought Cosworth and so re-directed its business there. There's an interesting behind-the-scenes insight into this in the book with Mountune boss David Mountain explaining how the transition was made and how his company benefitted in the short term.

Most of the book thereafter is taken up with a season-by-season guide to how it did, illustrated with some fine pictures and punctuated with driver profiles and technical developments. As Robson highlights in the book, a total of 97 cars, all solely for competition use, were built from 1999 to 2010 that between them scored 44 outright World Rally Championship victories, including two Manufacturers' titles in 2006 and '07. Although Colin McRae, Marcus Gronholm, Mikko Hirvonen and Jari-Matti Latvala were all runners-up in the World Rally Championship for Drivers, the car was unable to deliver a Drivers' title.

There are six appendices that encompass all the important facts including the Works drivers from 1999-2010 and the car's rally highlights in the same period. HRT

Subaru Impreza Group A Rally Car

1993-2008 (includes all rally cars)
Owners' Workshop Manual
Andrew van der Burgt
Published by Haynes Publishing
ISBN 978-1-785211-10-2
156 pages
£22.99



AS author Andrew van der Burgt acknowledges, the Subaru Impreza did more than any other race or rally car to transform the image of a brand. Even today, long after we are used to seeing the Impreza on the international rally stage, seeing one on the road evokes strong memories.

A very important element in the car's success was British company Prodrive along with STi in Japan. Between them they developed the car that defined rallying for its era.

Before the model came along, Subaru was an unknown make outside Japan. As the author points out in the first chapter, the carmaker made tentative steps into motorsport in 1980 when it entered a 4x4 Leone in the Safari Rally. After a few years campaigning this car, it then focused its efforts on the Legacy, by which time Prodrive had entered the picture, involved with the official homologation in January 1990. It was also the year that Subaru became involved in the Coloni Formula 1 team in what turned out to be a disaster. Three years later, though, came the Impreza and there was no looking back for Subaru.

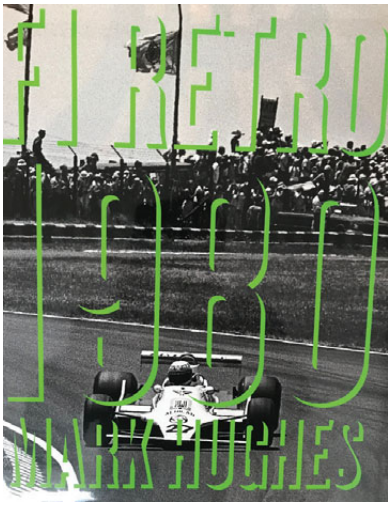
As van der Burgt explains, the car did not have a particularly auspicious start, but the writing was on the wall for everyone to see. The 1000 Lakes in Finland was chosen as its maiden event with a driver pairing of Markku Alén and Ari Vatanen who between them had won the event nine times. On the very first stage, though, Alén made a mistake and the car was out of the event.

Meanwhile Vatanen took the fight to Juha Kankkunen driving a Toyota, but ultimately finished second, 47 seconds behind the winner. The cars would not be seen again until the RAC Rally in November, but as the author notes, the warning shots for Subaru's rivals were loud and clear, as history went on to prove.

A chapter on the anatomy of the Group A Impreza that contains some great technical information, along with some fine anecdotes, technical specifications and great period pictures make this book a must for anyone interested in rallying history and the Impreza in particular. HRT

F1 Retro 1980

Mark Hughes
Motor Sport Magazine
ISBN 978-1-999748-10-4
280 pages
£60.00



THIS book, written by Formula 1 journalist Mark Hughes, should be high on the wish list of many readers of this magazine as it deals with a period in which so many people are interested. This is the time when the likes of Gilles Villeneuve, Didier Pironi, Alain Prost, Nelson Piquet, Carlos Reutemann, Mario Andretti – in fact, one can go on and on – were centre stage and the racing was open and dangerous. It was also a time when it was difficult to forecast who would win a race.

It was also the time when aerodynamics was growing in importance while turbocharging was finding its feet. However, Alfa Romeo was still campaigning its V12 while Ferrari had both a Flat 12 and a turbo V6 while of course there was the venerable Cosworth V8.

The book also has some nice touches with the UK and US hits at the time of every race being highlighted. For example, at the time of the USA West race in Long Beach, The Jam were number 1 in the UK with Going Underground while in the US, Pink Floyd was enjoying success with Another Brick in the Wall.

There are some fabulous pictures, one of Villeneuve having a real moment in Italy showing the car exploding into pieces. Alongside it is a piece on Jody Scheckter's view on just how dangerous the sport was which gives a real insight into just what the drivers were exposed to at that time.

There is a chapter on all the different cars that were raced in Formula 1 in 1980, reviving memories of the Tyrrell 010, Osella FA1, the Ligier JS11/15 and the Ensign N180, and another chapter on aerodynamics and how ground effect was still being investigated by the teams. It was also the year when the first moves to carbon fibre were being made, eventually displacing aluminium honeycomb.

£60.00 might seem a lot of money for a publication on just one year but it really is a fabulous book. The cover is rather poor and does not do justice to what is between the covers, but once you get past that, it is a treasure trove of information. HRT

A REALIGNMENT OF PRIORITIES

Want to go faster? **Alan Stoddart** finds out there are seconds to be gained from having the alignment down to a T

There are a huge number of ways to improve competitiveness on track; everything from bolting on new parts, taking driving lessons and even spending time mastering a track in a simulator can offer substantial gains. One of the most important steps in going quickly that can easily be overlooked however, is perfecting a car's setup.

Achieving the perfect set up typically meant wrestling with tape measures, spirit levels, bits of string and chalk marks on the floor, before checking the corner weights, and then more often than not having to go back and sort the alignment all over again. This is a struggle that Absolute Alignment's Motorsport Alignment System seeks to end by combining a state-of-the-art Bluetooth aligner with corner weight scales to offer a more holistic approach to car set up. The package is totally portable and can be run from a single laptop, be it at home in the garage or at the side of a track before qualifying.

"Just as it's important for a road car to be correctly aligned, so a race car is responsive to tiny changes in set up," explains Absolute Alignment's technical director Chris Dear.

"Many drivers in 'club' historic motorsport lighten or stiffen their cars without paying attention to the bigger picture. Our equipment can help find the correct settings in a fraction of the time it takes a pencil and a length of string."

The benefits of using the comprehensive set up are impressive. At one outing in Zandvoort, Max Tyler, who has since become the firm's marketing manager, found a second and a half by using the system. "We were at Zandvoort... and he [Dear] said 'go on, give this system a go'," Tyler recounts.

"I was racing an MG Midget and I'd freshly built it and I thought I'd got the wheels pointing vaguely in the right direction with an old tracking gauge. I was quite pleased with it until we put it on the aligner. Even with the minor adjustments available on the MG, as nothing is multi-adjustable or anything, but just by getting the ride heights and the corner weights set we found a second and a half."

The other benefit of this system is that it is easy to use and enables the car to be worked on while in position. "Adjusting the car was a doddle," adds Tyler. "We jacked it up and put it on the floor plates. It was high enough that I could get underneath it and fiddle with the track rods until it all came right."

A second and a half is a really substantial amount of time to be gained from simply setting the car up right, and serves as a testament to the power of alignment. One and a half seconds. "Think how much that would cost at the engine builder," concludes Dear. HRT

> **"How much would one and a half seconds cost at the engine builder?"**



ABOVE Absolute Alignment's Motorsport Alignment System takes the legwork out of sorting setups



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